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MODELING OF WHOLE-BODY RESPONSE TO WINDBLAST

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AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
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NOTICES

TECHNICAL REVIEW AND APPROVAL

AFAMRL-TR-83-073

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

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Previous development of the ATB Model was sponsored by the AF Aerospace Medical Research Laboratory. The development of the closely related Crash Victim Simulator (CVS) program was sponsored by the National Highway Traffic Safety Administration and the Motor Vehicle Manufacturers Association.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MODELING OF WHOLE-BODY RESPONSE TO WINDBLAST, COMPUTER SIMULATION, HUMAN RESTRAINT SYSTEMS, THREE-DIMENSION DYNAMICS, AERODYNAMIC FORCES, MATHEMATICAL MODEL, WINDBLAST, CRASH VICTIM SIMULATION, EJECTION SEATS, WIND TUNNEL TESTING, ESCAPE SYSTEMS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Articulated Total Body (ATB) Model was modified for improved modeling of the biomechanics of the man/seat ejection problem. The new ATB-IIIA version of the model incorporates whole-body wind tunnel data to model windblast, an improved algorithm to simulate the ACES-II STAPAC assembly, and calculates the location of the instantaneous center-of-mass for either the man or the man/seat system.
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20. ABSTRACT (continued):

The enhanced ATB Model provides for the modeling of the ACES-II ejection sequence from initiation of ejection to man/seat separation. The data for several ejection simulations are provided and discussed in detail. An extensive literature search was conducted in the area of ejection, windblast response and restraint systems. A summary of pertinent reports and available wind tunnel data is provided, as well as recommendations for future wind tunnel testing to correct for deficiencies in currently available aerodynamic data.

PREFACE

This report describes the results of a study of the modeling of windblast response as it relates to limb flail injuries occuring during high speed ejection from aircraft. Particular emphasis was placed on determining the necessary modifications of the Articulated Total Body (ATB) Model so that it can be used to evaluate the performance of various windblast protective devices.

The research effort summarized in this report was performed for the Air Force Aerospace Medical Research Laboratory under Contract No. F33615-80-C-0511. Dr. John T. Fleck and Frank E. Butler of J&J Technologies Inc. developed the algorithms and the computer software required and Dante A. DiFranco of DiFranco Associates was responsible for the aerodynamic studies required.

The authors wish to acknowledge the suggestions and guidance provided by Dr. Ints Kaleps and Lt. Thomas R. Gardner of the Air Force Aerospace Medical Research Laboratory during the analytical and software development of this research effort. Lt. Thomas R. Gardner was the AFAMRL technical monitor on this contract.

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1.0 INTRODUCTION

The Articulated Total Body (ATB) Model used at the Air Force Aerospace Medical Research Laboratory, Modeling and Analysis Branch, has been particularly effective for predicting gross human body response in various dynamic environments. The objective of this research effort is to fully exploit this model's capability by developing comprehensive model inputs defining the ejection aerodynamic environment, recommending ATB Model modifications to optimize aerodynamic response modeling capabilities and to demonstrate the model's effectiveness for modeling the various physical phenomena associated with combined ejection and windblast exposures.

To this end, an extensive literature search was performed to assess the availability of information on aircraft ejections and response to windblast forces. The findings of this search are reported in Section 2 of this report along with recommendations for further testing and data analysis.

In order to assess the modeling capabilities of ATB program temporary modifications were made to the ATB Model to simulate the drogue chute, the STAPAC (pitch rate correcting subsystem) and to introduce experimentally obtained aerodynamic data. These modifications and the results of several test runs are presented in Section 3.

Section 4 describes the permanent improvements to the ATB Model which were developed under this contract. These improvements are: an algorithm to eliminate drift in the joints, an algorithm to automatically relocate Harness points, and the computation of various instantaneous dynamic global quantities relating to the sets of segments used to simulate the man-seat (or other) systems.

Section 5 proposes an algorithm that may be used to compute maximum stresses in long-bone segments such as found in the limbs. This algorithm should be useful in assessing various injury potentials by means of simulations.

Appendices A and B contain the input and output listings of the computer test runs presented in Section 3. The Input Description of the Articulated Total Body (ATB-IIIA) Model is presented in Appendix C. Appendix D presents the program modifications and the descriptions of the new subroutines which were created during this research effort. Appendix E presents the listing of the Fortran IV Source Decks of the ATB-IIIA Model which were developed.

Throughout this report it is assumed that the reader is familar with the ATB Model. If the reader wishes a comprehensive description of the model he should refer to References 31, 34, and 35.

2.0 MODELING OF THE EJECTION SEQUENCE

2.1 LITERATURE SEARCH AND REVIEW OF EJECTION SEAT DATA

At contract initiation, a literature search was conducted of the available reports and unpublished data on aircraft ejections and the windblast response of the pilot-seat combination during ejection. Some of these reports served primarily as background information on ejections, escape systems, and escape problems. Of particular interest was the data available on the aerodynamic environment during ejection, how this environment is related to pilot flail injuries and the possible ways in which this aerodynamic environment can be modeled for inclusion in the Articulated Total Body (ATB) computer model. Incorporation of these data into the ATB Model will make it possible to study the dynamics of ejection under more realistic conditions, including limb restraints and limited limb motions. An adequate assessment of ejection dynamics and flail injuries requires an adequate assessment of the limits on limb forces and torques. Information available on the physical properties of the human body, ejection seats, seat recovery systems and subsystems, and advanced restraint systems was also considered important during this preliminary assessment. Finally, data available on simulated tests of ejections, including any existing computer programs, were also considered an important part of this review.

Computer searches and printed abstracts were utilized in conducting this review. The bibliography of Reference 1 was found to be very useful.

2.1.1 BACKGROUND INFORMATION

Reference 2 is a collection of papers presented at an AGARD meeting held in Toronto, Canada on May 6, 1975. The specific problems of windblast are considered in some detail in these proceedings by people from 5 nations. It is amply demonstrated statistically that the probability of windblast injuries can rise to 40 percent or more during high speed, high dynamic pressure ejections. Some of the papers discuss the injury mechanism and conclude that injuries are caused by excessive relative motion of the limbs with respect to the body or ejection seat. These relative motions are related to the differences in the ratio of aerodynamic forces to the mass or inertia of the limbs when compared to similar ratios for the body torso or the overall ejection seat. Some of the papers indicate that restraining limb motions and stabilizing the ejection seat will relieve the problem of windblast injury considerably. It is also indicated that helmet loss and head injuries are associated with aerodynamic pressures on the helmet.

The incidence of non-combat windblast injuries in the period 1964-1970 are analyzed and discussed in some detail in Reference 3. USAF experience is found to agree with British experience. Curves are derived from statistical analysis that indicate that at 400 KEAS (knots equivalent airspeed, i.e. airspeed at sea level in a standard atmosphere) the probability of injury from an ejection is 10 percent. The probability of injury rises to 50 percent and 90 percent at 500 and 600 KEAS respectively.

The basic mechanisms of limb flail injuries, when the limbs become dislodged, are discussed in Reference 4. Also discussed are the loads that can cause limb dislodgment. Simple concepts and dynamic models are presented to explain the process of limb dislodgment and flail injuries. The "Tractor Rocket Egress System", as an alternative means of egress, is also presented and discussed. Low speed wind tunnel measurements of body segment forces, using live human subjects, are presented for the symmetrical case of zero yaw and pitch and for simulated tractor rocket egress conditions.

Tractor escape systems and the problems associated with such systems are further discussed in Reference 5. A simple theoretical analysis is made of the dynamic motion of the crew member as he is pulled by the extraction pendant. Included in the analysis are the aerodynamic forces on the crew member and the pendant. The possible advantages of a "ballistic" extractor as opposed to a rocket extractor are also discussed. Also presented are limited wind tunnel measurements of crew member forces during simulated extraction from the cockpit of an aircraft.

Reference 6 discusses a number of advanced concepts of protective restraint systems for aircrew members. These systems are especially applicable to escape at very high speeds with high multiaxial acceleration. These systems include such concepts as articulated ejection seats, inflatable restraints, and even a spherical capsule enclosure.

A preliminary study of the dynamics of ejection and its relationship to flail injuries under this contract must of necessity be limited because of the complexity of the problems and the lack of adequate data. It will be confined to fairly conventional ejection seats, such as the ACES II, and conventional restraint systems such as sliding belts and harnesses.

2.2 AVAILABLE DATA AND DATA REVIEW

2.2.1 WINDTUNNEL REFERENCES

An adequate assessment of the dynamics of ejections and the resulting limb forces and joint torques must of necessity be based on an adequate knowledge of the aerodynamic forces and moments on both the man/seat and the limbs of the seat occupant.

Reference 7 collects and correlates the scattered and limited aerodynamic data available on the human body. Unfortunately, the experimental aerodynamic data available at the time Reference 7 was written is essentially low speed data on the body alone in three positions (supine, sitting, and standing). These results indicate that significant differences can exist between clothed and naked subjects. Reasonable correlation of the data is possible based on "force area" and "moment volume" coefficients. "Force area" and "moment volume" coefficients are obtained by dividing forces and moments by the free-stream dynamic pressure. Changes in subject size and shape are correlated based on the assumption that the aerodynamic "force area" and "moment volume" is proportional to $\sqrt{WL}$ and $L\sqrt{WL}$ respectively. W is the subject weight and L is the subject height. Data is presented and correlated for the three static force and the three static moment coefficients through a range of yaw angles from 0 to 180 degrees for the three subject positions. The data is of limited usefulness since it does not consider the subject seated in an ejection seat. In addition, the data does not include angle of attack and mach number as important variables.

Reference 8 presents wind tunnel measurements on stability and limb dislodgment forces with the F-105 and ACES-II ejection seats. Both seats are shown to be unstable and generally out of trim both with and without an occupant. It is shown that the seat can be made stable when equipped with stabilizing surfaces. Forces on both arms and legs were measured over a range of speeds, for various subjects, through a limited range of pitch and yaw angles. The limb forces varied from one individual to another and also with appurtenances attached to the limbs. The appurtenances reduced the limb forces under some conditions and made them worse under other conditions. The test results also indicate that powerful lift forces can develop on helmets due to the aerodynamic pressures and that these forces can result in helmet loss or neck injuries if the retention strap is strong enough to resist the loss. The results are presented in the form of both "force area" and "moment volume" coefficients for pitch angles from -15 to +15 degrees and yaw angles of 0 to -30 degrees. A limited amount of data at zero pitch is also presented for yaw angles up to 180 degrees. Generally, hand and foot forces on the ACES-II seat are greater than those on the F-105 seat. Dislodgment forces are sufficiently high to result in limb dislodgment and flail at high speeds. Again, the angles of attack, angles of yaw, and mach number range of these test data are quite limited.

Reference 9 extends the wind-tunnel data of Reference 8 to a larger range of combined pitch (-15 to 60 degrees) and yaw angles (0 to 180 degrees) with human subjects and anthropomorphic dummies. Instrumented hand and foot rests were used to measure limb dislodgment forces. The tests results indicate that the dislodgment forces are reduced as the pitch angle of the model in the tunnel is increased. These data also indicate that over large ranges of pitch and yaw angles the ACES-II seat/occupant combination is unstable.

In the tunnel tests of Reference 10 the lift component of the hands and feet dislodgment forces and the force between the occupant and seat are measured for a range of pitch and yaw angles. Hand lift forces decrease and feet lift forces increase with an increase in pitch angle up to 60 degrees. A large part (80 percent) of the drag force of the man/seat combination acts on the man at small pitch angles.

Reference 13 extends the wind tunnel testing of Reference 8 thru 10 to asymmetric configurations with an anthropometric dummy in an ACES II ejection seat. The asymmetrics considered are the occupant shifted to one side, asymmetric positions of the right and left hand and configurations with arms and legs in flailing positions.

Reference 14 presents some preliminary wind tunnel test results using a 1/2 scale model of a crewman in an ACES-II ejection seat. These tests were run up to mach numbers of 1.4, pitch angles up to ±30 degrees, and yaw angles from 0 to 30 degrees. In these tests the limbs were instrumented to measure bending moments at two stations on each lower leg, thigh, forearm, and upper arm. Bending moments were measured in two directions, both in and out of the plane of the limb. Reference 14 was published primarily as a preliminary or interim analysis report for the purpose of assessing the structural integrity of the wind tunnel model because of the failure of the neck member during testing. Unfortunately, the data presented are in raw form in terms of forces in pounds and moments in inch-pounds. No attempt is made to reduce these data to "coefficient form" and to correlate and analyze the data in any detail. In these tests the forebody and cockpit of the F-16 airplane were simulated, including various positions of the ejection seat with respect to the forebody.

One of the most thorough collections of aerodynamic test data on ejection seats with crewmen is presented in Reference 15. These data are based on wind tunnel tests conducted on a full scale F-101 ejection seat and a half scale F-106 ejection seat. Aerodynamic data were obtained at mach numbers from 0.2 to 0.8 and 0.6 to 1.5 for the full scale and half scale models, respectively. Angle of attack varied from 0 to 360 degrees for the half scale model and -45 to +90 degrees for the full scale model. Yaw angles varied from 0 to 45 degrees. Catapult rocket plume effects on seat aerodynamics was simulated in the half-scale tests using compressed air. From these tests it is possible to obtain both rocket on and off aerodynamic data. Complete static force and moment coefficient data, three force and three moment coefficients, are presented in tabular form.

Comparision of these data with other model test data appears to substantiate the conclusion that seat and crewman size and shape has no significant effect on the coefficients if they are based on the projected frontal area of the seat with occupant, the seat hydraulic diameter, the free stream dynamic pressure, and an axis system with its origin at a common seat reference point (SRP). The hydraulic diameter or seat reference length is the diameter of a circle whose area is equivalent to the projected frontal area. The SRP is located at the base of compressed seat back in the plane of symmetry of the seat. The axes system is the standard body axes system with X-axis perpendicular to the compressed seat back with its origin at the SRP. The axes system Z-axis is in the plane of symmetry. Force and moment data with respect to an axes system with the origin at the man/seat C.G. is obtained by a simple transfer from the axes system through the SRP.

The data of Reference 15 indicates the effects of the rocket plume on aerodynamic coefficients are a function of altitude because of the effect of altitude on rocket plume expansion. Force and moment coefficients are also a function of mach number, angle of attack, and angle of sideslip. Changes in the crewman hand positions also affect seat aerodynamics.

These aerodynamic data have been used by the Crew Escape and Subsystems Branch, Vehicle Equipment Division of the Flight Dynamics Laboratory to conduct computer simulations of six degrees of freedom dynamic motions of cockpit seat ejections with an occupant (Reference 32). These simulations have been made using the SAFEST computer program.

The tabulated aerodynamic data of Reference 15 are available on tape and are the primary source of man/seat aerodynamic data for the modified ATB computer Model used in a study of ejection dynamics in this research effort.

Statistical information on head injuries and the efficacy of helmets is contained in Reference 16. It is concluded that shoulder harnesses and lap belts are most important in preventing head injuries and that helmets reduce the severity of head injuries. Another conclusion is that the loss rate of flight helmets increases with airspeed and is due to the aerodynamic pressure on the outside of the helmet.

The results of wind tunnel tests on flight helmets are presented and discussed in Reference 17. These tests were run with volunteer subjects in an ACES-II seat. In these tests the dynamic pressure varied from 10 to 50 lbs per sq.ft., the pitch angle varied from -2 to 73 degrees, and the yaw varied from 0 to 30 degrees. The conclusions that can be drawn from these tests is that large upward and side forces can be developed on a helmet in combined pitch and yaw. These forces can be of the order of 500 lbs or larger at 600 KEAS. A spoiler on a helmet reduces the upward pressure force significantly.

Reference 26 is a preliminary, unpublished "Data Package" on ejection crewman wind tunnel tests conducted at AEDC. This package contains test data on a crewman. The test package contains total force and moment coefficient data for the seat with occupant as well as crewman helmet forces. Component force and moment data are presented on the upper arm, lower arm, upper leg, and lower leg. These particular test results were obtained without an airplane forebody. Test mach numbers varied from 0.20 to 1.4. The yaw angles varied from 0 to 30 degrees and the pitch angles varied from -30 to +30 degrees. In its present form these data are of limited usefulness since they are preliminary, undocumented, and the limb force data are in unreduced form. The data may be useful in assessing limb forces during ejection when properly reduced, correlated, and documented.

Reference 27 is a preliminary draft of an unpublished report on wind-tunnel tests of a 1/2-scale man/seat model. These tests were conducted on the man/seat in proximity to an F-16 forebody as well as on the man/seat alone. Some analysis of the data is presented. Based on the data, mathematical models have been established for the aerodynamic forces acting on the total man/seat, the crew-member's limbs, and the helmet. The mathematical models appear to be based on a Taylor's series expansion in terms of variables such as seat ejection position, angle of attack, angle of yaw, and mach number. In some mathematical models some variables are fixed and the order and number of terms retained varies from model to model. Both force area and moment volume coefficients are fitted. How the data fit to the models and the rationale used for dropping particular terms is not explained. Success in performing fits of the mathematical models to the data is mixed. A least-squares fit of force and moment data to a Taylor's series expansion in the important variables does appear to be an approach with promise. Such mathematical models can then be incorporated in the ATB Model computer program to assess limb forces and moments during ejection.

Reference 28 is an annex to Reference 27 and consists of complete plots of the experimental data. Force and moment data, integrated limb forces, helmet forces, and pressure data are plotted. Plots are presented for the configurations man only, basic model, basic model and windshield, and basic model with flow diverter.

2.2.2 SLED-TRACK REFERENCES

Reference 29 is a presentation of tabulated and plotted data of an actual ejection seat test with a 95 percentile dummy (95% of the population weigh as much as this dummy or less) using an F-15 forebody model with an ACES-II seat at an ejection speed of 445 KEAS. Seat and dummy linear accelerations and roll, pitch, and yaw rates are tabulated and plotted. No text or explanation and analysis of the test results is presented.

2.2.3 MATHEMATICAL MODELS AND SIMULATIONS

POTENTIAL FLOW MODELING

Reference 11 and 12 are interesting theoretical investigations of limb forces using potential flow theory. The forearm was selected for this preliminary investigation. To account for viscous effects and flow separation which results in drag forces, Reference 12 suggests that the potential flow of a vortex pair which results from the flow separation in the wake region of the limb be combined with the potential flow due to the cross flow. The goal of these investigations is the development of a mathematical model for limb aerodynamic forces which can be incorporated in AFAMRL's Articulated Total Body (ATB) computer Model for the purpose of assessing the kinematics of body limb motions and the ejection conditions which can result in flail injuries. Unfortunately, viscous effects, separated flow, and flow interference effects between body members and the seat are very complex and an adequate model using this idealized potential flow approach seems out of reach. This is especially the case for a highly three dimensional object such as a pilot/seat where relative motion between limb members is permitted.

SAFEST PROGRAM

Reference 32 compares data from an ejection seat track test to the results obtained using a six-degree-of-freedom computer program. In the computer, seat subsystems are modeled through computer subroutines. Aerodynamic forces and moments are important components of the total forces and moments acting on the man/seat during ejections. Time histories of the computer response variables are compared to track test results. The SAFEST computer program was used in the simulation. The observed linear acceleration trends compare reasonably well with the test data but the angular rate comparisons are generally poor. This program considers the man/seat to be a rigid body and does not consider limb motions or forces during ejection. The SAFEST Computer program contains 115 subroutines which account for various aspects of ejection dynamics.

EASIEST PROGRAM

Reference 33 is essentially a user manual for the EASIEST computer program. The EASIEST computer program combines the SAFEST program subroutines on ejection seat analysis with Boeing's EASY program for linear and nonlinear analysis of system dynamics. Reference 33 describes in some detail various aspects of the EASIEST program. Section IV and Appendices G and H describe in some detail EASIEST STANDARD components and subroutines. Appendix D presents EASIEST input/output lists. Also included in Appendix D are Figures which describe many of the ejection seat standard components simulated during an ejection such as aerodynamic plates, aerodynamic forces and torques, catapult forces and torques, drag and recovery parachute forces, forces and torques on the seat from the STAPAC and the sustainer rocket, etc.

ATB PROGRAM

Reference 31 describes the ATB-II Model. Some of the features of this model are a harness belt system, rate dependent force producing functions, and arbitrary specification of the motion of multiple segments. These refinements are the basis for the further developments of the ATB Model as presented and discussed elsewhere in the present report.

2.2.4 ADDITIONAL TYPES OF DATA FOR EJECTION SEAT MODELING

LIMITS ON LIMB FORCES AND TORQUES

A knowledge of the limits on limb forces and torques and adequate biomechanical models of limb joints are important when assessing potential limb injuries during ejection using the ATB Model.

Reference 18 is a statistical study of grip retention forces for "twin grip" handles and "ring" types such as the D-ring. It is interesting to note that grip retention forces are based on the "probability of letting go". For any given grip force the probability of letting go is a function of the magnitude of the force, its time of duration, and the class or type of grip. Smaller grip forces, shorter duration times, and "twin grips" all result in smaller probabilities of letting go. If grip retention forces are exceeded due to windblast forces on the arms, then the hands will be pulled off the grip and the arms will flail.

Reference 19 is an investigation of knee flail design limits through a study of the composition, structure, and mechanical properties of knee ligaments. The results of this study are used to establish design criteria for the prevention of torsional injuries to knees during ejection. Design limits in the form of angles and torques for the onset of failure are established.

Reference 20 describes a research program formulated and developed to collect data on the resistive forces, moments, and torques of major human joints such the shoulder, knee, hip, elbow, and ankle. This research was conducted on live human subjects, with obvious limitations, using experimental apparatus especially designed for this purpose. Also involved in the research was a review of joint models and theoretical research as well as the presentation of experimental numerical results. The purpose of this study was to provide reasonable biomechanic models and numerical data of articulated joints that can be used in the ATB Model for a better assessment of joint injuries during ejection.

RESTRAINT SYSTEMS

Reference 30 defines 6 possible candidates for an ejection seat restraint system and proposes a program for refinement, evaluation, and final selection of one of the proposed candidates. These candidates are based on design requirements for restraint systems developed from criteria for constraints for the system. The requirements are ranked and significant interactions, especially negative interactions, are used to identify the trade-offs required in a successful design. A review of previous restraints and injury mechanisms are also important considerations for selecting the 6 candidate protection systems. It should be possible to evaluate these protection systems using the ATB Model.

OTHER PHYSICAL PROPERTIES

A knowledge of the physical properties of ejection seats and their occupants is essential for a proper evaluation of ejection dynamics. This preliminary study of ejection dynamics using the ATB Model will concentrate on the ACES II ejection seat. A knowledge of the physical properties of the ACES II seat and its subsystems is therefore an important component in this research effort.

If an ejection seat occupant is to be studied and modeled as part of the total physical system in some way, then information on the physical properties of body segments can be useful. Reference 21 is an investigation of the weight, volume, and center of mass of body segments determined using 13 male cadavers. Reference 21 establishes the relationships between size, weight, and volume of body segments. These results become the basis for estimating these parameters for living subjects.

Reference 22 is an extensive investigation of static center of gravity and inertia properties of ejection seats with an occupant. Experimental results on these properties were obtained using the AFFDL Center of Gravity/ Inertia Meter. Approximately 150 runs were made with 32 human subjects and 5th, 50th, and 95th percentile dummmies using F-84, F-100, F-105, F-106, and F-4 ejection seats. The effects of various seat configuration changes on the center of gravity and inertia properties were also investigated. Estimates of the center of gravity and the inertia properties of the ACES-II seat with various percentile occupants are based on the tabulated data of Reference 22.

Reference 23 is a general description of the operation of the Advanced Concept Ejection Seat (ACES) which is produced by the McDonnel Douglas Corporation. This report was helpful in understanding the various modes of operation of the seat, the time sequence of events during ejection, and how the various seat subsystems work. Of special interest for this research effort are details on the operation of the seat sustainer rocket, pitch control (STAPAC), and drogue parachute subsystems.

Reference 24 contains a detailed description of the ACES-II seat development and qualification testing. It is a useful source of descriptive information as well as actual numerical test results obtained during qualification testing. Some of the information in Reference 24 was useful in formulating mathematical models for the ACES-II subsystems.

Reference 25 contains a great deal of information on parachutes and other recovery systems. It was an especially useful source of information on the Hemisflo drogue chute which is part of the ACES-II ejection seat recovery system. It is possible to obtain information on chute drag coefficients and opening load factors from Reference 25. It is also a source of detailed information on how to evaluate chute deployment times and forces such as snatch forces, chute inflation or filling times, opening load factors, and chute steady-state loads.

2.2.5 SUMMARY OF AVAILABLE DATA

A summary of the aerodynamic test data that is presently available on ejection seats and occupants is presented in tabular form in Table 1 that follows. This table is divided into 4 parts: Part(a) presents the physical configuration of the tests, Part(b) shows the test variables and the ranges of these variables, Part(c) lists the static forces and moments measured, and Part(d) indicates the body segment forces, moments, and the joint torques that were measured, if any. Also shown in the table are the references in which specific data appear. Not all references are listed. Many did not contain specific or significant aerodynamic data that are applicable to ejection seat aerodynamic modeling. A few clarifying comments on test conditions and test data presented in the references are listed in Part(e) of Table 1, the comment section.

It is difficult to summarize the effects and sensitivity of many of the variables evaluated in the testing such as appurtenances, yaw, pitch, mach number, clothing, aircraft forebody, asymmetry, rocket plume, etc. Specific effects of one variable are often dependent on the specific conditions of other variables. It will suffice to say that under the many and variable conditions of ejection many of these variables are important and their effects are very interdependent. One must refer to the specific references for further details.

TABLE 1 - AERODYNAMIC TEST DATA SUMMARY

(a) PHYSICAL CONFIGURATIONS OF TESTS

Ref.	Scale	Ejection Seat	Subject	Clothing	Aircraft Forebody	Seat Restraint	Seat Asymmetry	Appurte-nances
4	Full	Yes/No	Human	Yes/No	No	Yes	No	Yes
5	Full	Yes/No	Human	Yes	Yes/No	Yes	No	No
7	Full	No	Human	Yes/No	No	No	No	No
8	Full	Yes	Human	Yes	No	Yes	No	Yes
9	Full	Yes	Human/ Dummy	Yes	No	Yes	No	No
10	Full	Yes	Human	Yes	No	Yes	No	No
13	Full	Yes	Dummy	Yes	No	Yes	Yes	No
14	1/2	Yes	Dummy	No	Yes	No	No	No
15	Full 1/2	Yes Yes	Dummy Dummy	Yes No	No No	Yes No	No No	No No
17	Full	Yes	Dummy	Yes	No	Yes	No	Yes
26	1/2	Yes	Dummy	No	No	No	No	No
27	1/2	Yes	Dummy	No	Yes/No	No	No	No
28	1/2	Yes	Dummy	No	Yes/No	No	No	No

TABLE 1 - AERODYNAMIC TEST DATA SUMMARY (CONT.)

(b) TEST VARIABLES AND RANGES

Ref.	Test Facility	Mach No. Range	Pitch Ang. Range	Yaw Ang. Range	Rocket Plume Simulation	Alt. Simulation
4	Tunnel	Low Speed	None	None	No	No
5	Tunnel	Low Speed	±15°	None	No	No
7	Tunnel	Low Speed	None	0° to 180°	No	No
8	Tunnel	Low Speed	±15°	0° to -30°	No	No
9	Tunnel	Low Speed	-15° to 60°	0° to 30°/ 0° to 180°	No	No
10	Tunnel	Low Speed	-15° to 60°	0° to -30°	No	No
13	Tunnel	Low Speed	±30°	±30°	No	No
14	Tunnel	.2 to 1.4	±30°	0° to 30°	No	No
15	Tunnel	.2 to .8 .6 to 1.5	-45° to 90° 0° to 360°	0° to 45° 0° to 45°	No Yes	No Yes
17	Tunnel	Low Speed	-2° to 73°	0° to 30°	No	No
26	Tunnel	.2 to 1.1	±30°	0° to 30°	No	No
27	Tunnel	.2 to 1.2	±30°	0° to 30°	No	No
28	Tunnel	.2 to 1.4	±30°	0° to 30°	No	No

TABLE 1 - AERODYNAMIC TEST DATA SUMMARY (CONT.)

(c) TOTAL STATIC FORCE AND MOMENT MEASUREMENTS

Ref.	Lift Force	Drag Force	Side Force	Roll Moment	Pitch Moment	Yaw Moment
4	None	Yes	None	None	None	None
5	Yes	Yes	Yes	Yes	Yes	Yes
7	Yes	Yes	Yes	Yes	Yes	Yes
8	Yes	Yes	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes	Yes	Yes
10	None	None	None	None	None	None
13	Yes	Yes	Yes	Yes	Yes	Yes
14	Yes	Yes	Yes	None	None	None
15	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
17	None	None	None	None	None	None
26	Yes	Yes	Yes	Yes	Yes	Yes
27	Yes	Yes	Yes	Yes	Yes	Yes
28	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 1 - AERODYNAMIC TEST DATA SUMMARY (CONT.)

(d) BODY SEGMENT FORCE, MOMENT, AND JOINT TORQUE MEASUREMENTS

Ref.	Hand Forces	Knee Forces	Elbow Forces	Foot Forces	Helmet Forces	Upper Arm	Lower Arm	Upper Leg	Lower Leg	Torso
4	Yes	Yes	None	Yes	Yes	Forces	Forces	Forces	Forces	Forces
5	(See Comments that follow the Table)									
7	None	None	None	None	None	None	None	None	None	None
8	Yes	Yes	None	Yes	Forces/ Moments/ Pressures	Forces	Forces	Forces	Forces	None
9	Yes	Yes	None	Yes	Yes	Forces	Forces	None	None	None
10	Yes	None	None	Yes	None	(Arm UP	Forces)	(Lift	Forces)	Forces/ Moments
13	None	None	None	None	None	None	None	None	None	None
14	None	None	None	None	Yes	Moments	Moments	Moments	Moments	None
15	None None	None None	None None	None None	None None	None None	None None	None None	None None	None None
17	None	None	None	None	Yes	None	None	None	None	None
26	None	None	None	None	Yes	Forces/ Moments	Forces/ Moments	Forces/ Moments	Forces/ Moments	None
27	None	None	None	None	Yes	Forces	Forces	Forces	Forces	None
28	None	None	None	None	Yes	Forces	Forces	Forces	Forces	None

TABLE 1 - AERODYNAMIC TEST DATA SUMMARY (CONT.)

(e) COMMENTS

Reference	Comments
4	F-105 ejection seat used for some tests. Tests with ejection seat and occupant measure primarily hand, knee, and leg forces. These forces and other forces were also measured for a tractor rocket egress configuration (occupant without seat).
5	In tests with a cockpit, vertical height above cockpit during egress was an important variable. Test were run primarily to simulate a configuration for a tractor egress escape systems (suspended subject without seat). Harness, torso, wrist, knee, and ankle forces were measured.
7	Test data for subject without seat in only standing, sitting, and supine positions. Drag data compared to other available data on humans and dummies.
8	Tests with F-105 and ACES-II ejection seats. Tests with appurtenances on limbs, stabilizer plates on seat, and nets on limbs. Force, moment, pressure measurements on helmets. Total forces and moments measured at zero pitch for yaw of 0 to 180 degrees.
9	ACES II ejection seat used in tests. Gross force and moment data measured for 5 and 95 percentile anthropomorphic dummies for yaw from 0 to 180 degrees.
10	Tests with ACES II ejection seat.

13 Tests with ACES II ejection seat and 50 percentile anthropometric dummy.

Asymmetric configurations:

(a) Shift of dummy to one side in seat

(b) Various asymmetric locations for arms and legs.

14 This is a preliminary report and data analysis

Limited and unreduced data - not in coefficient form.

Arm moment data in and out of arm plane at six stations including elbow and shoulder.

Leg moment data in and out of leg plane at six stations including knee and hip.

15 This is the most complete set of correlated test data on the total static forces and moments of ejection seats over a large range of mach number, angle of attack, and yaw angles.

F-101 and F106 ejection seats were used in these tests.

The test data are in coefficient form and applicable to a wide variety of ejection seats. Test data include the aerodynamic effects of the seat and the rocket exhaust plume on the forces and moments.

17 Helmet lift and side force data is presented both with and without a loss preventer (spoiler).

26 A good source of data on limb forces and moments.

Total force and moment coefficients are presented in force area and moment volume form.

Upper and lower arm and leg side force, drag, lift and moments were measured for both arms and legs.

Drag, side, and lift forces on the helmet are presented.

27 Primary concern is curve fitting and comparing experimental data in graphical form.

Ejection seat vertical distance above the forebody was an important variable in some of the test data presented.

28 This is presently the most complete source of data on limb forces and moments and helmet forces under realistic ejection conditions. All data are plotted.

Tests were run with a 1/2 scale (1)man-seat, (2)man-seat and cockpit, (3)man-seat with cockpit and windshield, (4)man-seat with cockpit and flow diverter.

Ejection seat vertical displacement was a variable in these tests.

Lift, drag, and side forces on the helmet were measured.

Pressure coefficients were also measured at one point on the head, chest, abdomen, left leg, right leg, and seat back.

2.3 RECOMMENDATIONS FOR WIND TUNNEL TESTING AND DATA ANALYSIS

Ample evidence exists that limb dislodgment forces can be large during ejection at high speed in an open ejection seat. Large limb dislodgment forces can result in limb flail injuries. For example, data from Reference 10 indicate that "arm-up" forces of the order of 500 pounds are easily possible at 500 KEAS. Reference 18 shows that hand grip forces of this magnitude can result in a "probability of letting go" of 90 percent or higher. Obviously, under such conditions an unrestrained arm will flail. Reference 3 indicates that the probability of arm flail injury occuring under such flight conditions can be of the order of 30 percent or higher. For ejection speeds above 500 KEAS the probability of flail injury increases dramatically. At 600 KEAS or higher flail injury will approach near certainty. Thus it appears that limb restraints are required during ejections for any modern day high speed fighter if flail injuries are to be avoided.

2.3.1 A REALISTIC EJECTION SEAT MODEL

A realistic ejection seat model for inclusion in the ATB Model computer program is one that includes the ejection seat, occupant, and the important seat subsystems such as sustainer rocket, STAPAC, and drogue chute. Such a model should also consider the occupants' limbs to be restrained by some sliding belt and harness system. Six typical belt and harness restraint candidates are discussed in Reference 30. Such restraints allow limited arm and leg motions. With such a model one can consider limb motions as well as body motion within the seat as small movements or perturbations from fixed limb and body positions. Such a model will allow large motions of the seat and fixed occupant but only small displacements of limbs and the body within the seat. An investigation of potential injuries during ejection can then be performed by applying such a model to analyzing seat dynamics, limb and restraint dynamics, limb forces, and joint torques.

Before an assessment of limb forces, joint torques, and potential injury conditions can be made an appropriate sliding belt and harness model must be available. In addition, aerodynamic forces and moment data on the total seat and the various limb segments must be available under the conditions of limited limb and body motions. A body of experimental data presently exists on seat forces and moments (Reference 15). Under the restrictions of limited limb and body motions within the seat, the problem of obtaining experimental wind tunnel data on aerodynamic forces and moments on the limbs appears tractable. In fact some of these data exists at present but have not yet been properly reduced (References 27 and 28).

2.3.2 DATA ANALYSIS

In Reference 27 and 28 a large body of experimental data is presented on limb forces as well as data on total seat forces and moments. In Reference 27 a preliminary attempt has been made to correlate and curve fit some of these data. A least-squares curve fit should be undertaken using the experimental variables of mach number, angle of attack, angle of sideslip, and seat ejection position with respect to the cockpit. Preliminary results presented in Reference 27 appear to indicate that acceptable least-squares curve fits of the experimental data are possible if up to cubic terms are retained in a Taylor's series expansion. Such curve fits should be made especially for the upper and lower arm and upper and lower leg force data of Reference 28. These limb force fit equations can then be included as part of the ATB Model computer program for a preliminary assessment of limb aerodynamic forces and moments during ejection. This modified program can also be used for a preliminary evaluation of limb motions with any specific belt and harness restraint system.

As the limbs move within any restraint system, the forces on the limbs are a function of the limb positions as well as the ejection seat variables. The data of Reference 27 and 28 does not in general evaluate the effects of various limb positions on the limb aerodynamic forces, therefore this preliminary evaluation of limb aerodynamic forces and their effects must of necessity be limited. The angle of attack and sideslip angle range of the data of References 27 and 28 is also limited, but such an analysis should result in significant insight into the interrelationships between ejection dynamics, limb forces and moments, and the potential ejection conditions that may result in limb injuries. The results of such a study should also be the basis for formulating future wind tunnel test programs to measure limb aerodynamic forces and moments with limited limb movements.

2.3.3 FUTURE TUNNEL TESTING

A body of experimental aerodynamic data presently exists on an ejection seat with occupant and these data are presently being used to study ejection dynamics (References 15 and 32). These data are for the condition with the body and limbs fixed with respect to the seat. In these tests the mach number was varied from 0.2 to 1.5. For some of the tests the angle of attack was varied through 360 degrees. The angle of yaw varied between 0 and 45 degrees. Reference 27 and 28 contains a body of experimental data on upper and lower arm and upper and lower leg forces. These forces take the form of drag, lift, and sideforce measurements on limb segments. For these tests the angle of attack was limited to $\pm$ 30 degrees and the yaw angle varied between 0 and 30 degrees. Most of these tests were run with the occupant and his limbs at one fixed position in the ejection seat. It is necessary to expand these limb force data. Wind tunnel measurements should be made on limb segment forces and joint torques through the mach number, angle of attack, and yaw angle range of Reference 15 allowing some small changes or perturbations in the limb positions.

The amount and direction of the limb segment perturbations to be tested should be based on the data analysis described in the previous section. It should be possible to limit the limb perturbation variables to only a few. Since the limb perturbations are small, changes in many of the aerodynamic interaction effects between limb segments, and between segments and the seat, will probably be small and negligible. If this is the case then it will not be necessary to test all possible combinations of the wind tunnel test variables (mach number, angle of attack, angle of sideslip and relative seat position) and limb perturbation positions.

It is difficult to state at this time what the limb position perturbation variables should be. These perturbation variables can be defined better once the data analysis suggested in the previous section is completed. The wind tunnel test variables should be comparable to those of Reference 15, except that it would be advisable to increase the test yaw or sideslip angles to 90 degrees. It may not be necessary to run tests of limb position perturbation for the complete matrix of the wind tunnel test variables. It would also be advisable in these tests to instrument the limb segments of the model to measure joint torques as well as segment forces.

The limb segment force and moment data obtained from these tests as a function of the limb position perturbation variables can then be fitted to analytic expressions that involve the wind tunnel test variables as well as the segment position perturbation variables. A least-squares fit technique may be appropriate and should be based on the results of the data analysis suggested in the previous section. The terms in the analytic expressions to be fit can be determined from a Taylor's series expansion. Appropriate simplifications of the analytic expressions should be made when possible. The analytic expressions can then be added to the ATB Model computer program for an assessment of limb segment forces and joint torques during actual computer simulated ejections.

3.0 MODELING OF THE ACES II EJECTION SEQUENCE WITH THE ATB MODEL

3.1 ATB MODEL CHANGES

As a result of the studies that have been conducted during this research effort it has been determined that to adequately model the dynamic response of the man-seat the ATB Model must be able to simulate the effects of stabilizing rockets, STAPACs, and the drogue chute in addition to accounting for the windblast forces on the man-seat. In order to assess the importance of these effects the ATB Model was modified and several test runs were made. This modified version is designated as ATB-IIIA and a complete description of the program changes is given in Appendix D. Much of this effort is preliminary and not yet fully developed, hence many of the input parameters required for the tests are embedded in the FORTRAN code.

3.2 ACES EJECTION SEQUENCE AND MODELING

The ACES II system operation is described in detail in Reference 24. A typical time sequence of events during ejection is illustrated in Figure 3-1 (this Figure was copied from a Figure in Reference 24). Typical times in seconds are:

1	$t = 0$	initiation of ejection,
2	$t = 0.001$	catapult ignition,
3	$t = 0.198$	pitch STAPAC ignition,
	$t = 0.203$	pitch STAPAC operational,
4	$t = 0.208$	drogue chute initiation,
	$t = 0.213$	catapult phase ends, seat free, sustainer ignition,
	$t = 0.215$	drogue gun reaction forces and moments end,
	$t = ts$	drogue line stretch, start of snatch, this time varies,
	$t = ts + 0.026$	time of maximum snatch force,
	$t = ts + 0.052$	time of end of snatch force,
	$t = tf$	drogue filled, this time varies,
	$t = 0.653$	sustainer rocket burnout,
	$t = 0.800$	STAPAC rocket burnout,

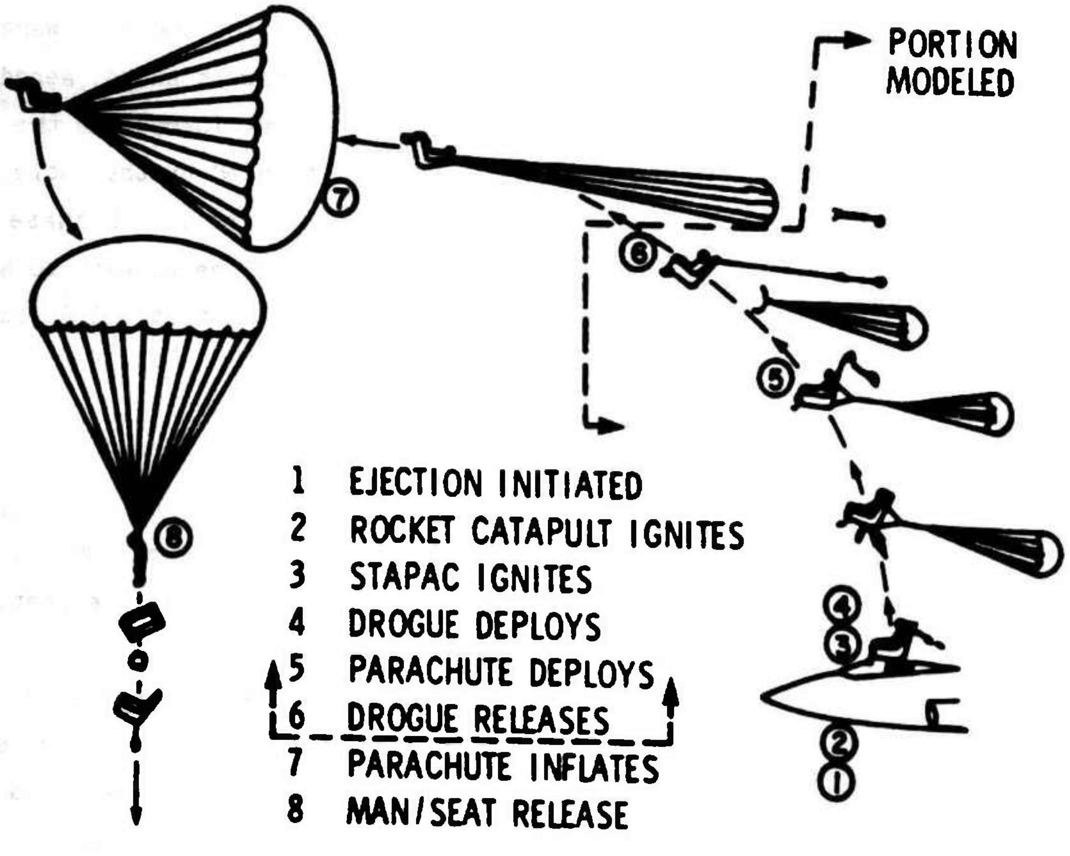

Figure 3-1 EJECTION SEQUENCE

5 t = 1. + parachute (main chute) deploys (not modeled),
6 t = 1.312 drogue chute release.

The times used in the preceding table were taken from data supplied by Mr. Dobbek of the Flight Dynamics Laboratory at WPAFB and are for the Mode 2 operation of the seat. Mode 2 refers to a recovery mode above 275 KEAS at sea level.

In the ATB simulations, the initial conditions for the seat were taken to be the values which existed at the end of the catapult phase, aerodynamic forces and moments were introduced, the sustainer rocket forces and the droque gun reaction forces were begun at the times indicated by the table. Thus only gravity is acting on the seat until the initiation of these other forces. The user may modify the initial conditions, if he wishes, to account for the effect of gravity (primarily a change in the vertical velocity of the seat).

3.2.1 SUSTAINER ROCKET(S)

The sustainer rocket is rigidly attached to the seat and, when ignited, applies a time varying thrust in a direction fixed relative to the seat.

The sustainer rocket can be modeled by using the program's ability to specify a time-varying force applied at a specified point on any segment. Section 5.2 of this report contains a description of the mathematical model which is used in the ATB Model. The user supplies the time varying force (one of the F's in equation 5.1 of Section 5.2), the segment number to which it is applied and the location (the corresponding R in equation 5.1 of Section 5.2) in the segment where the force is to act. Details of this capability are contained in the input description of the ATB Model (Appendix C) and the specific use for these test runs in Appendix D. In particular, the sustainer rocket force function is defined in tabular form as FUNCTION NO. 1 in the output listings given in Appendix B of this report and is plotted in Figure 3-2. Hence, no program modifications are required.

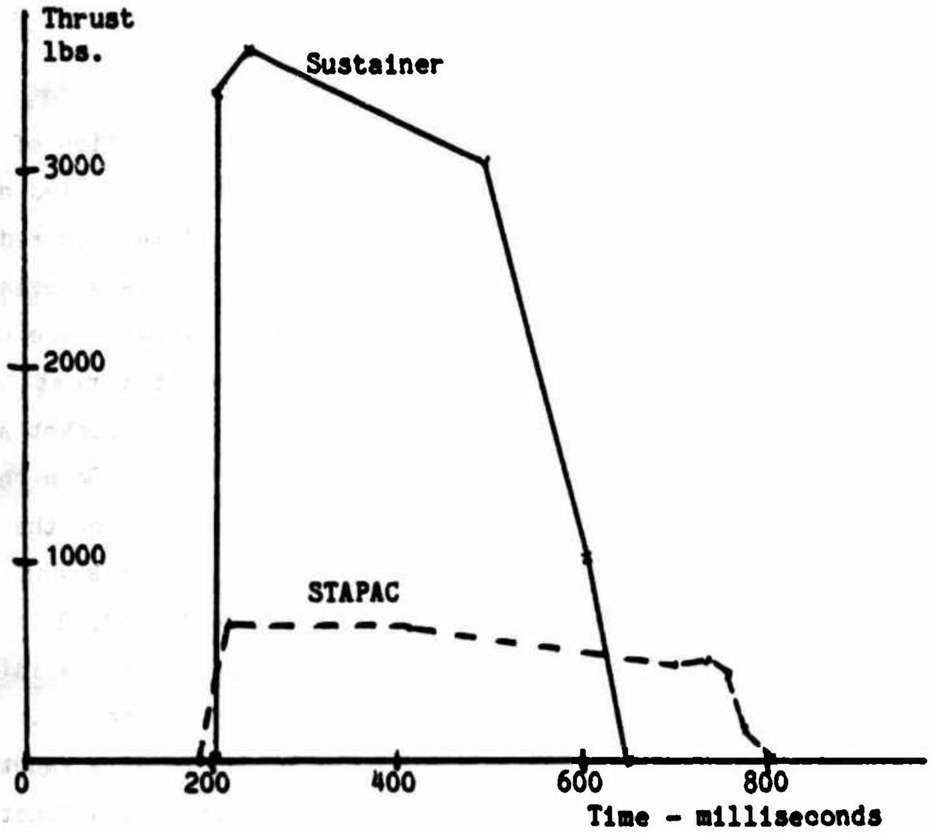

Figure 3-2 ROCKET THRUST

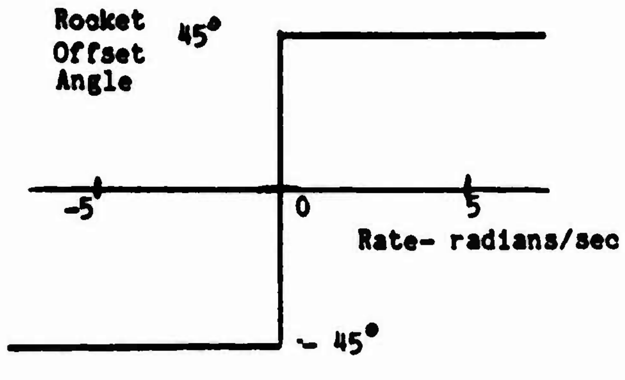

Figure 3-3 STAPAC Pitch vs Rate

3.2.2 STAPAC

The STAPAC is basically a sustainer rocket where the direction of the thrust vector is dependent on the angular velocity about a specified axis of the seat and is directed to produce a torque which will tend to reduce this angular velocity. The ATB Model was modified on a temporary basis to model the STAPAC which counteracts the pitch rate of the man-seat. The user supplies the force versus time function defining the rocket thrust, the location and initial angle of the rocket and the angle of the rocket as a function of angular rate of the segment to which it is attached. Both these functions are supplied using the function definition capability of the ATB Model. As in Section 3.2.1 the user defines one of the F's and the corresponding R of equation 5.1 of Section 5.2 (see FUNCTION NO. 2 in the output listings in Appendix B for the force function and cards D.9 in the same listings). This rocket thrust function is plotted in Figure 3-2. The program was modified to change the direction of the force, F, as a function of the pitch rate of the segment (man-seat) using the user specified function (see FUNCTION NO. 3 in the output listings given in Appendix B of this report). This rocket offset function is plotted in Figure 3-3. See the description of program modifications labeled STAPAC ROCKET in Appendix D for more specifics of the modifications. Details for entering functions are contained in the input description of the ATB Model. The temporary modification is restricted to the use of the STAPAC for control of pitching.

Program modifications:

Subroutine WINDY

Subroutine WINDY has been modified to test if the force function number is negative to activate the program for the STAPAC rocket. The pitch rate is computed and used as the argument to a second function that gives the angular deviation to be applied to the nominal firing angle of the rocket. The force evaluated from the first function (as a function of time) is then applied at this new firing angle.

Subroutine SINPUT

Subroutine SINPUT has been modified to accept a second function on input Cards D.9.a - D.9.j (the 2I6 term at the beginning of the FORMAT for Cards D.9 has been changed to 3I4). Also vectors QFU, QFV and QFX are stored in COMMON/WINDFR/ as needed for the STAPAC rocket. QFU is a unit vector in the direction of the nominal thrust of the rocket relative to the seat. QFV is the location of the rocket with respect to the center of gravity of the seat (man-seat) and QFX is a unit vector defining the axis of the rate sensor.

Optional output

NPRT(30), not equal to 0, prints one line of data at each time point. This line contains: time, pitch rate, angular deviation, direction cosines of the firing angle, and components of the resulting force and torque vectors. This output is intended primarily for diagnostic purposes.

3.2.3 DROGUE CHUTE

The actual deployment and resultant effects of the drogue chute on the seat motion are quite complex. The ATB Model was modified on a temporary basis to include a simplified version of the effects of the drogue chute. In the typical deployment of a chute, a capsule is ejected from the seat with a rocket, this capsule causes an extraction chute to be deployed which in turn releases the main drogue chute. Forces created by the chute are transmitted to the seat via a bridle. The reaction due to the release of the capsule was modeled by using a time dependent force capability to apply thrust to the seat (this is the same technique as used for the sustainer rocket described above). The chute was modeled as an independent segment. The bridle was modeled using the spring function capability of the program. It was assumed that the bridle apex was rigidly attached to the chute, i.e. all the riser and suspension lines were assumed to be rigid and all of the 'line stretch' was in the bridle (Figure 3-4). A time dependent force was applied to give the chute a velocity relative to the seat. A force, dependent

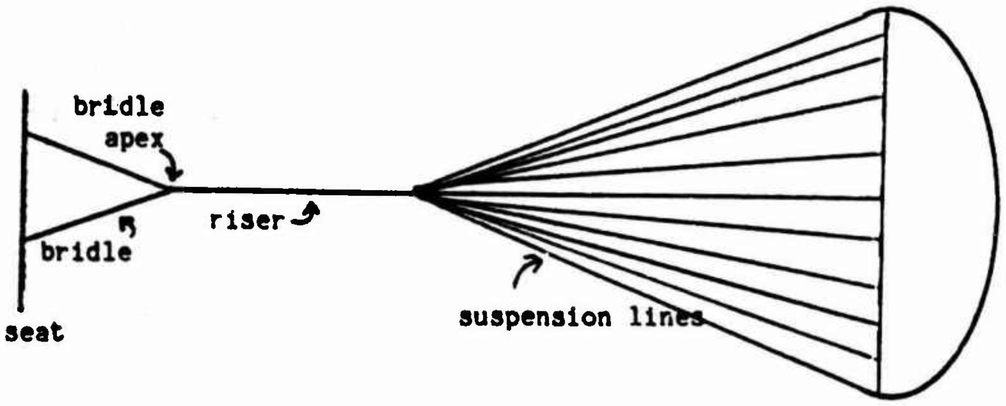

Figure 3-4 DROGUE CHUTE

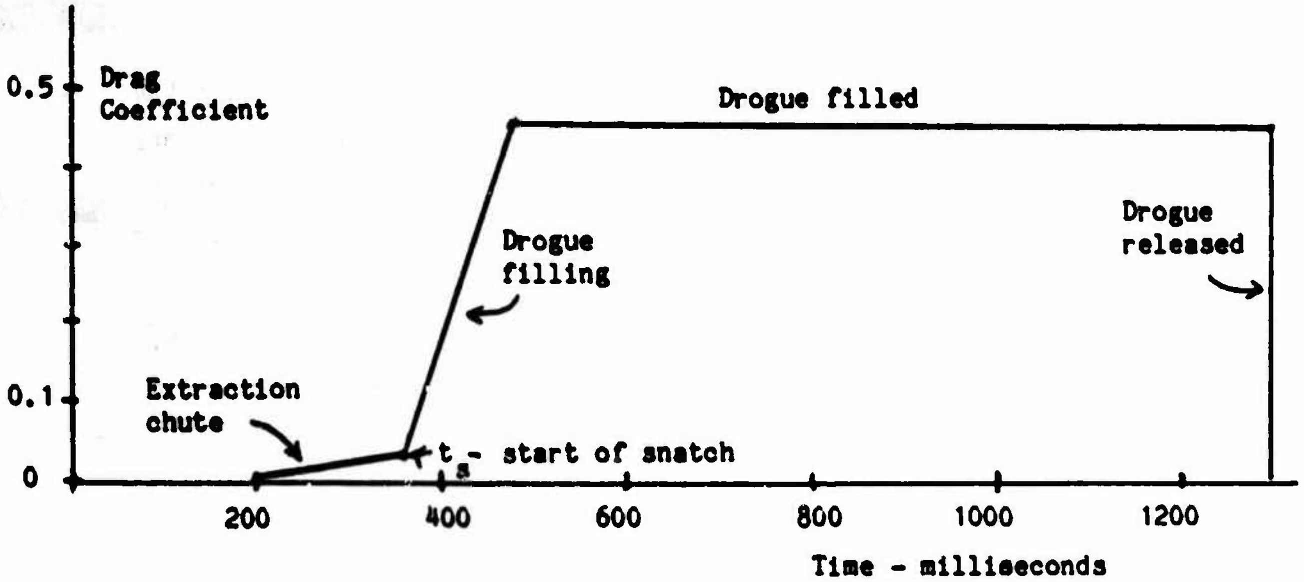

FIGURE 3-5 CHUTE - DRAG COEFFICIENT

on dynamic pressure of the wind stream and a time dependent drag coefficient, was applied to simulate the wind forces on the chute. The time dependent drag coefficient must be selected to account for the effects of both the extraction chute and the drogue chute itself in determining the position and velocity of the drogue chute. This drag coefficient is illustrated in Figure 3-5. The specific details of the modifications are given in Appendix D in the section labeled DROGUE CHUTE where the drogue chute and the modifications to Subroutine WINDY are described. In sample runs it was found that the time dependence and magnitude of the 'snatch' force was very sensitive to the drag coefficient and the initial impulse applied to the chute.

Program modifications:

Subroutine WINDY

Additions have been made to Subroutine WINDY to compute the wind forces on a chute segment and these forces are controlled by supplying the ellipsoid number (MWSEG(2,J) on Input Card F.7.b) as a negative integer. The magnitude of the wind force acting on the chute is computed as

Force = $0.5*R*V^2*Area *C$

where: R = The air density stored in COMMON/ARODAT/ by Subroutine AIRFLW,

V = The velocity of the chute relative to the wind. The wind velocity is stored in COMMON/ARODAT/ by Subroutine AIRFLW

Area = PI*A*B where A and B are the y and z semiaxes of the ellipsoid of the chute segment supplied on input Card B.2.j,

C = The value of the user supplied function from input Cards E to specify the effective drag coefficient of the the drogue chute as a function of time.

The resulting forces and torques, applied at the end of the negative x axis of the chute ellipsoid, are added to the U1 (force) and U2 (torque) arrays.

3.2.4 AERODYNAMIC FORCES

As a result of the studies made under this research effort, it has been concluded that the aerodynamic forces acting on the man and/or seat are best modeled by using experimental data with appropriate interpolating routines to apply the forces to the various segments of interest. To this end, the program has been modified on a temporary basis to accept data where the normalized forces and moments acting on a segment are a function of mach number, angle of attack, and angle of sideslip. Two new subroutines were developed to introduce the aerodynamic forces, these are Subroutine AIRFLW which is called by Subroutine CONTCT and Subroutine ARODTA which is called by Subroutine AIRFLW. Subroutine AIRFLW computes the aerodynamic forces produced by the airstream and computes the resulting forces and torques which act on the segment. Subroutine ARODTA computes the aeromechanical coefficients using experimental data which is in a file maintainted by AFFDL on the CDC Cyber computer at WPAFB. Appendix D contains a detailed description of these subroutines.

Program modifications:

Subroutine AIRFLW(N), new subroutine

Subroutine AIRFLW is called by Subroutine CONTCT to compute the aerodynamic forces produced by the airstream and computes the resulting forces and torques acting on segment No. N.

Optional Output:

NPRT(29), not equal to zero, produces a tabular time history on the primary output unit. Time, mach number, angle of attack, sideslip angle, forces and torques acting on segment No. N are printed at a frequency of DT (Card A.4) seconds and is interspersed with other output that is printed on the primary output unit. No time points are printed when the time is less than TDELAY(1).

Subroutine ARODTA (VREL,CXYZ,CLMN,TBSR) - new subroutine

Subroutine ARODTA is called by Subroutine AIRFLW to compute the aeromechanical coefficients Cx, Cy, and Cz for forces and Cl, Cm, and Cn for torques, as a function of the mach number, angle of attack, and sideslip angle of the man-seat. The force and moment coefficient tables are given in reference 15, Report No. AFFDL-TR-74-57.

Arguments

VREL	The x, y, and z components of the velocity of the SRP in the seat body axis system with respect to the airstream.
CXYZ	The force coefficients Cx, Cy, and Cz that are returned to the calling program.
CLMN	The moment coefficients Cl, Cm, and Cn that are returned to the calling program.
TBSR	Remaining burner time of sustainer rocket. If negative and rocket-on data is being used, rocket-off data is read from input unit No. 10.

3.3 INPUT DATA SETS

Several preliminary test runs were made to verify the operation of the new subroutines that were discussed above. A final set of four runs using these new capabilities of the program were made. This final set modeled the man-seat as a single segment and the drogue chute as an independent segment. Two runs were made using a 95 percentile man and two runs were made using a 5 percentile man. All four runs used a mach number (M) of 0.908.

Data sets:

<u>Condition 1</u>

DESCRIPTION

1. High subsonic level flight at sea level (M = .908)
2. Comparable to Dobbek run on 1/18/80
3. Ejection mode 2

MAN SEAT PROPERTIES

1. ACES II ejection seat with 95 percentile occupant
2. Ejection weight (W) = 369.87 lbs.
3. Center of gravity (from SRP) - reference dimensions

   x = 6.13 in. frontal area = 6.94 sq.ft.

   y = .12 in. hydraulic diam. = 35.68 in.

   z = -9.51 in.
4. Inertia properties

   I_x = 18.35 lb.-ft.-sec.^{2} I_{xy} = -0.75

   I_y = 18.65 I_{xz} = 4.36

   I_z = 7.51 I_{yz} = -0.31

FLIGHT CONDITIONS (SEAT)

1. Ait (h) = sea level

2. Velocity = 600 KEAS

= 600 KTS (True) = 1013.4 ft./sec.

3. Speed sound (a) = 661 KTS

4. Mach number (M) = .908

5. Angle of attack = 12.5 degrees (seat), = 0 (airplane)

6. Angle of sideslip = 0

7. Angle of roll = 0

8. Angle of pitch = 12.5 degrees, angle of climb = 0

9. Velocity along body x, y, z axes

V_x = 585.8 KTS

V_y = 0

V_z = 129.9 KTS

10. Angular rates about body x, y, z, axes

p = 0 rad/sec. x-axis

q = 0 rad/sec. y-axis

r = 0 rad/sec. z-axis

11. Air density (rho) = .002375 slug/cu.ft.

12. Dynamic pressure (1/2 rho V_o^2) = 1219 lb./sq.ft.

CATAPULT ADDITIONS

V_x = 0	p = 0
V_y = 0	q = 0
V_z = -22.5 KTS	r = 0

CONVERSION FACTORS

1 ft./sec. = .5921 KTS

1 KT = 1.689 ft./sec. = 20.27 in./sec.

1 rad/sec. = 57.30 deg./sec. = .1592 rev./sec.

1 rev./sec. = 360 deg./sec. = 2 pi rad/sec.

Condition 2

DESCRIPTION

1. High subsonic level flight at sea level (M = .908)
2. Change in c.g. lateral offset
3. Same as ejection condition 1 with the following changes

MAN SEAT PROPERTIES

3. Center of gravity (from SRP)

   y = 0

Condition 3 (BASE LINE)

DESCRIPTION

1. High subsonic level flight at sea level (M = .908)
2. Change from 95 percentile to 5 percentile occupant
3. Ejection mode 2

MAN SEAT PROPERTIES

1. ACES II ejection seat with 5 percentile occupant
2. Ejection weight (W) = 298.80 lbs.
3. Center of gravity (from SRP) - ref dim.

   x = 5.04in. frontal area = 6.48 sq.ft.

   y = -.11in. hydraulic radius = 34.46 in.

   z = -8.14in.
4. Inertia properties

   I_x = 14.87 lb.-ft.-sec.^{2} I_{xy} = -0.36

   I_y = 15.51 I_{xz} = 4.07

   I_z = 5.73 I_{yz} = -0.09

FLIGHT CONDITIONS

1. Alt (h) = sea level
2. Velocity = 600 KEAS = 600 KTS(True)
3. Speed sound (a) = 661 KTS
4. Mach number (M) = .908
5. Angle of attack = 12.5 degrees
6. Angle of sideslip = 0
7. Angle of roll = 0
8. Angle of pitch = 12.5 degrees, angle of climb = 0
9. Velocity along body x, y, z axes

   V_x = 585.8 KTS

   V_y = 0

   V_z = 129.9 KTS
10. Angular rates about body x, y, z, axes

    p = 0

    q = 0

    r = 0
11. Air density (rho) = .002375 slug/cu.ft.
12. Dynamic pressure(1/2 rho V_o^2) = 1219 lb./sq.ft.

CATAPULT ADDITIONS

V_x = 0 p = 0

V_y = 0 q = 0

V_z = -27.9 KTS r = 0

Condition 4

DESCRIPTION

1. High subsonic level flight at sea level (M = .908)
2. Change from c.g. offset of y = -0.11 in. to y = 0
3. Change from sideslip angle = 0 to sideslip angle = 0.5 degrees
4. Same as ejection condition 3 with following changes

MAN SEAT PROPERTIES

3. Center of gravity (from SRP)

   y = 0.

FLIGHT CONDITIONS

6. Sideslip angle = 0.5 degrees

9. Velocity along body x, y, z axes

$$V_x = 585.8 \text{ KTS}$$

$$V_y = 5.1 \text{ KTS}$$

$$V_z = 129.9 \text{ KTS}$$

3.4 RESULTS OF TEST RUNS

The sample runs that were made using the aerodynamic forces, sustainer rockets, STAPAC and drogue chute on a man-seat configuration proved to be very sensitive to many of the parameters involved indicating the need for a much more detailed study than could be performed during this research effort. In particular the motion of the man-seat was extremely sensitive to a small offset of the c.g. in the y direction indicating the inherent 3-D nature of the problem. Also the 'snatch' force of the drogue chute was critically dependent on the specification of the drag coefficient of the chute. Since this 'snatch' force can be exceptionally large it can have a significant effect on the forces which act on the occupant.

The output listings for the four test runs are contained in Appendix B of this report. Note that the time history of the computations done by Subroutine AIRFLW are listed on the primary output unit. In particular the outputed variables are the time (in msec.), mach number, angle of attack, sideslip angle, the forces on the segment (Cx, Cy, and Cz), and the torques on the segment (Cl, Cm, and Cn). These outputs are interspersed with other output on this primary unit.

The four runs are:

Condition 1	95 percentile man, lateral c.g. offset
Condition 2	95 percentile man, no lateral c.g. offset
Condition 3	5 percentile man, lateral c.g. offset
Condition 4	5 percentile man, no lateral c.g. offset

The man-seat angular displacement for Condition 2 is plotted in Figure 3-6 and for Condition 4 is plotted in Figure 3-7. It should be noted that the angular displacement is just in the pitch angle. The corresponding runs (Condition 1 and Condition 4) show significant amounts of yaw and roll but the total resultant angular displacement (not plotted, refer to Appendix B) is about the same. The non-zero yaw and pitch angles are induced by the lateral offset of the c.g., which is of the order of one tenth of an inch.

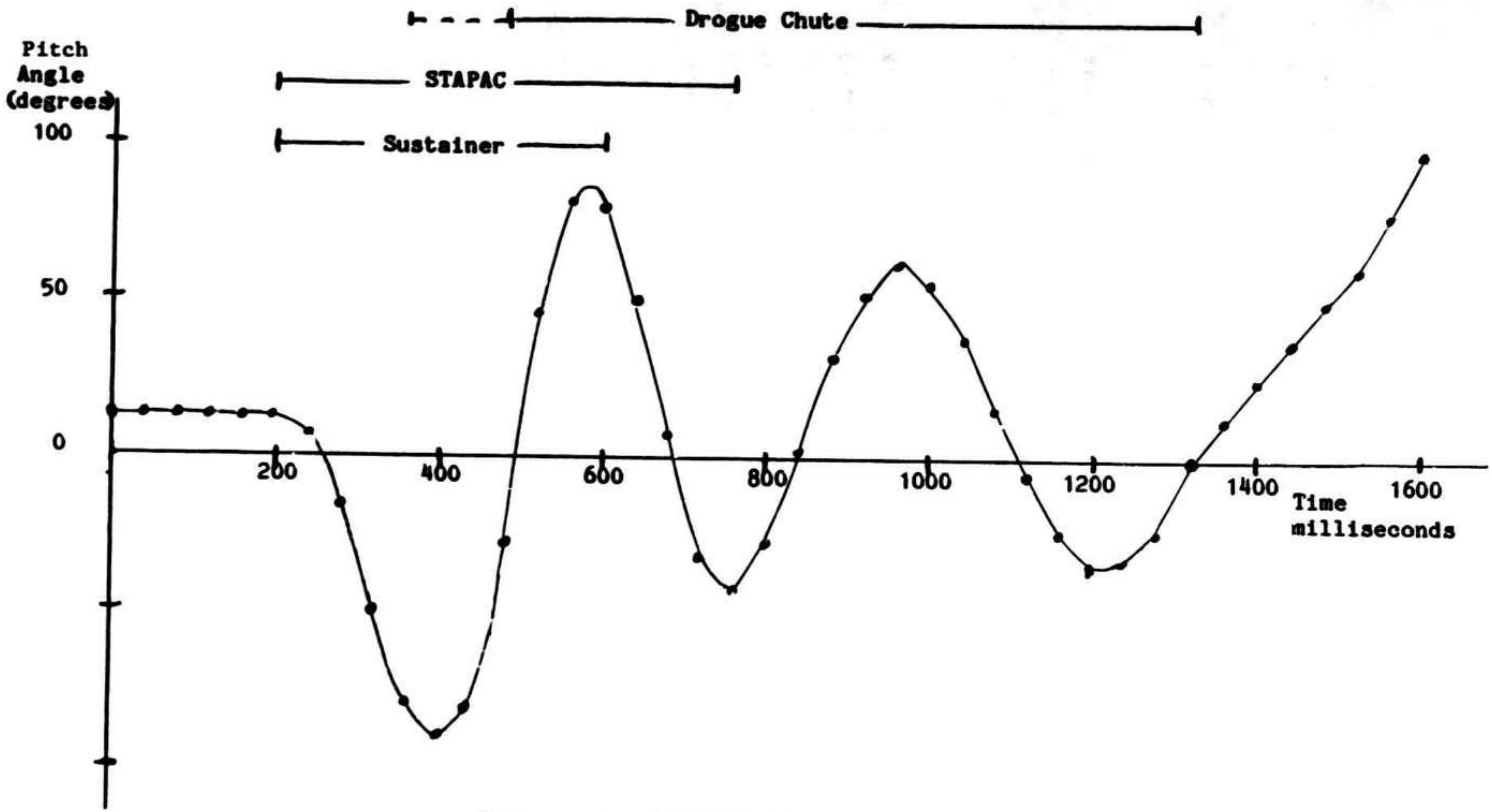

Figure 3-6 ANGULAR DISPLACEMENT MAN(95%) - SEAT

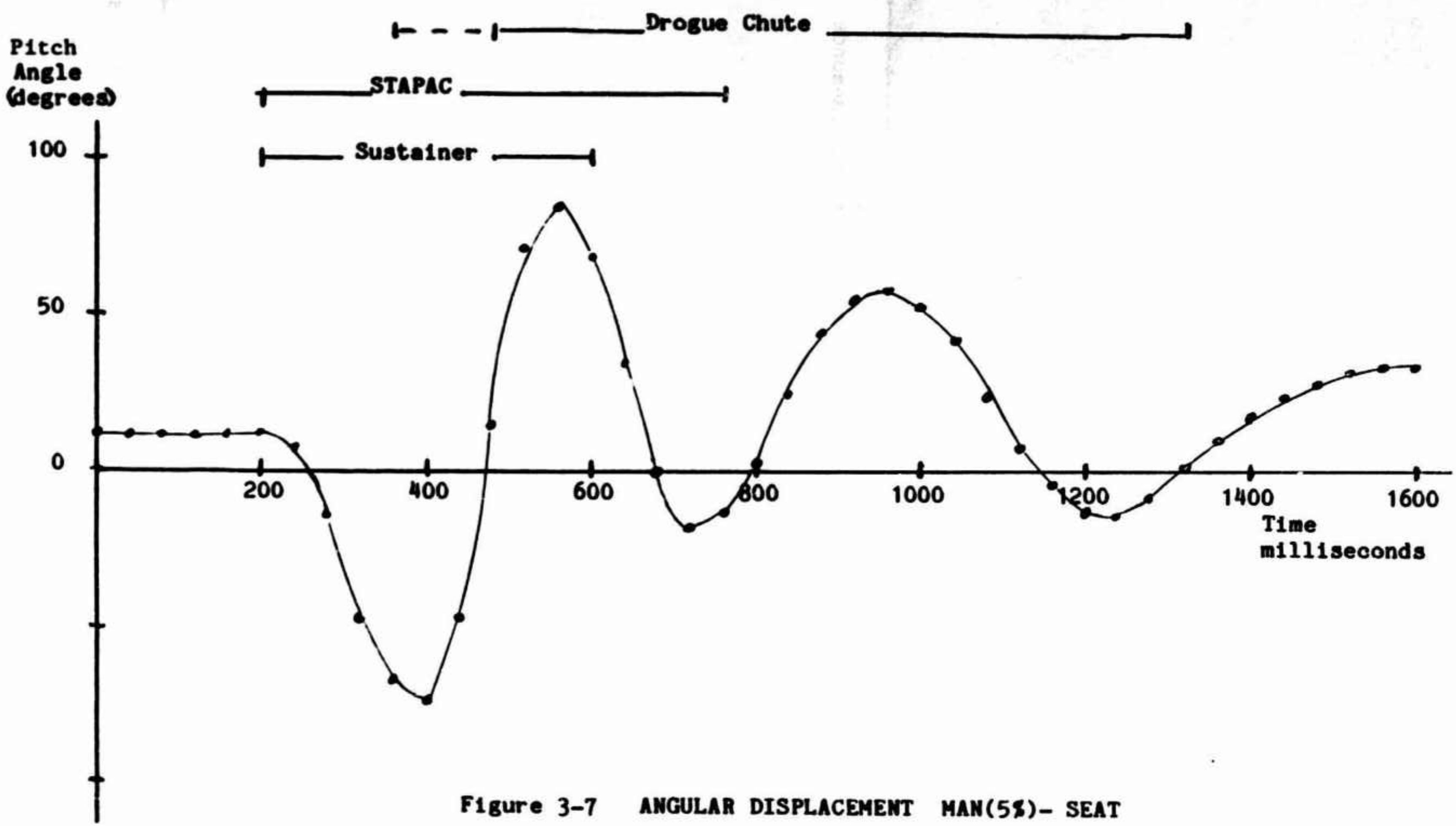

Figure 3-7 ANGULAR DISPLACEMENT MAN(5%)- SEAT

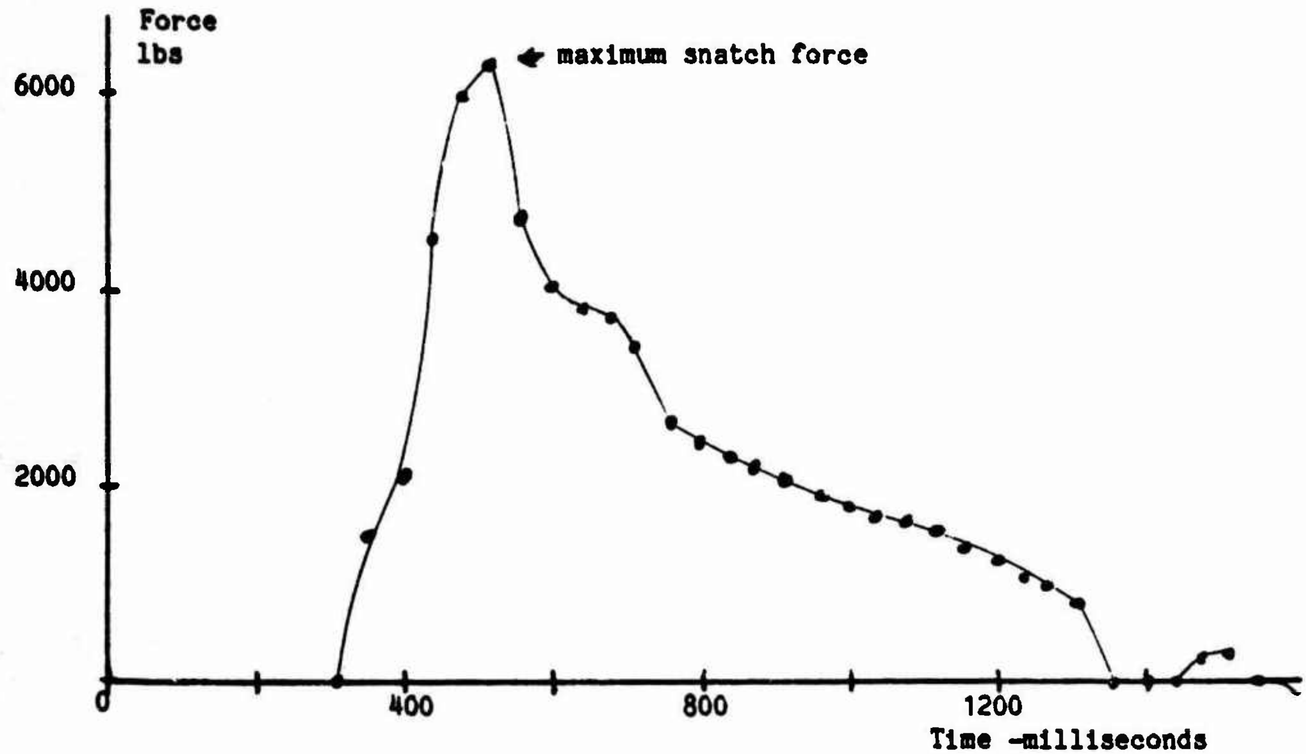

Figure 3-8 BRIDLE FORCE - MAN(95%) - SEAT

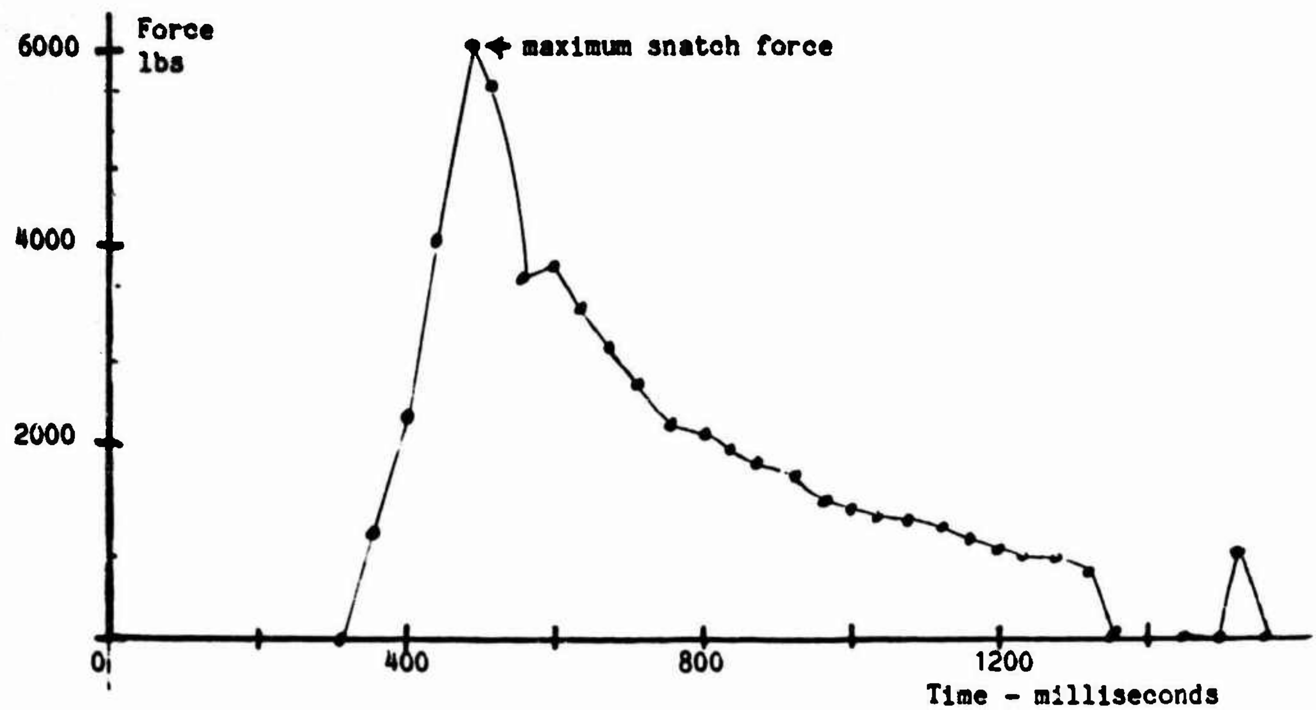

Figure 3-9 BRIDLE FORCE MAN(5%) - SEAT

The reaction of the drogue chute may be determined by looking at the time histories of the spring damper forces. These are plotted in Figures 3-8 and 3-9 for Conditions 2 and 4 respectively. Again note the effect of the offset of the c.g. by referring to these forces for the other conditions in Appendix B (not plotted).

It must be remembered that these test runs were performed only to demonstrate the ability to use the ATB Model to simulate the sustainer rockets, the STAPAC, the drogue chute, and the aerodynamic forces. No attempt was made to compare these results to other simulations or to actual flight data.

3.5 RECOMMENDATIONS

As a result of these tests and other studies performed in this contract effort, it is recommended that the following modifications be considered for the ATB Model:

Sustainer Rockets

No modification is necessary. The ability to apply a time dependent force at a prespecified location and in a prespecified direction is already in the ATB Model.

STAPACs

The operation of a STAPAC should be analyzed in greater detail to determine if it is necessary to model the dynamics of the STAPAC itself. The temporary modification that was done assumed that the STAPAC responded instantaneously to a change in direction and did not account for any dynamic reactions. It is recommended that a STAPAC model be incorporated into the ATB Model and that it have the capability of responding to the angular rate on any preselected axis (the temporary modification was restricted to the pitch axis).

Drogue Chute

The temporary modifications indicate that the drogue chute can be modelled as a separate segment using the spring dampers as the bridle and subjected to aerodynamic forces. However the response of the chute was very sensitive to the time-dependent drag coefficient and to the initial impulsive force that was applied to simulate the drogue gun reactions. Methods of predetermining an adequate drag coefficient time history need to be developed. Several auxiliary programs were written in an attempt to determine this drag coefficient but no conclusive results were obtained. In particular these programs attempted to determine the initial impulse applied to the chute and the slopes of the sections of the drag time history in order to achieve a realistic 'snatch' force at the appropriate time. The fact that the results of these auxiliary programs were inconclusive indicates that more work should be done in this area.

This drogue chute should be incorporated into the ATB Model. It should also provide a capability of modelling the main chute.

Aerodynamic Forces

The Subroutines AIRFLW and ARODTA should be incorporated into the ATB Model. Tabular time histories of the significant variables should be provided.

In the temporary modifications it was necessary to make a provision for extrapolating the experimental data if the angle of attack or the sideslip angle exceeded the range of the available data. The technique used was to take the last available value, better extrapolating methods, such as Fourier Series and/or Spherical Polynomial representations should be investigated.

The available data are very limited in scope and hence very little is useful for an adequate description of the forces and moments acting on individual segments. An analytic determination of the aerodynamic forces is deemed beyond the current state of the art because of the complex nature of the airflow about segments which are so close to each other in the typical man-seat configuration. It is therefore recommended that further tests be made to experimentally obtain data on the forces and moments acting on the significant segments. These data should cover the dynamic ranges of mach numbers, angles of attack, and angles of sideslip that would be experienced in typical ejection problems. Since the primary objective is to evaluate 'windblast protective systems' the data on limb forces need only be obtained for limited motion of the limbs on the assumption that an unusually large motion of the limb would imply that the 'protective system' had failed. It is believed that interpolative procedures can be developed that can account for variation of the angle of attack and the sideslip angles resulting from motions of the significant segments.

Protective Systems

Various protective systems can be modeled using the Harness Routines in the ATB Model. A series of test runs should be made in which the limbs are allowed to move, constrained by 'belts', and subjected to aerodynamic forces using Subroutine WINDY and/or Subroutine AIRFLW. The purpose of these runs would be to provide data to enable one to further refine these routines if necessary.

4.0 PERMANENT ATB MODEL IMPROVEMENTS

4.1 DRIFT IN JOINTS

The ATB Model uses forces and torques of constraint to impose the kinematic constraints at the joints. The forces of constraint are to insure that the joints do not separate and the torques of constraint are used to impose angular constraints such as a locked joint, a pin joint or the various constraints related to the EULER joint. However, since the integration procedure is not exact, i.e. a discrete step numerical integration procedure must be used, and the computation is not of infinite precision, errors in the constraints will occur. The error in joint separation is eliminated by use of a chain routine to compute the linear positions and velocities of the segments. Previous versions of the ATB Model had no provision for chaining the angular constraints and some users have reported significant "drift" at the joints, e.g. the pin vectors at a pinned joint do not remain parallel. It has been found that the drift can be controlled by using more stringent integrator tests however this may necessitate a significantly longer running time than is desirable. An angular chaining procedure has been developed to eliminate this drift and is included in the ATB Model. Its use has been made optional.

4.1.1 ANGULAR CONSTRAINTS

There are three basic types of joint constraints. They are:

1) Locked joint, all types of joints except the null joint may be locked.
2) Pin joint, IPIN = 1 or an EULER joint with two axes locked.
3) EULER joint with only one axis locked.

The ATB Model allows the joints to change their state (locked or unlocked, within limits) at the completion of a successful integrator step (update time). At this time if a joint changes state the relative orientation of the adjoining segments may be saved for use by the chaining procedure.

The chaining procedure used for these constraints is:
The joint array JNT(j) is scanned sequentially from j = 1, to j = NJNT. Joint j connects segment i = JNT(j) to segment j+1. If i = 0 the joint is a null joint and no constraints are applicable. If the joint is locked then the direction cosine matrix of segment j+1 could be computed from the direction cosine matrix of segment i and the relative orientation at the time of lock, however no drift has been experienced for a full locked joint so no correction is made. If the joint is a pin joint (or an EULER joint with one free axis) the direction cosine matrix of segment j+1 is adjusted so that the pin vector in segment j+1 is parallel to the pin vector in segment i. If the joint is an EULER joint (see Figure 4-1) with one axis locked the direction cosine matrix of segment j+1 is adjusted so that the spin and precession axes are perpendicular to the nutation axis and the angle on the locked axis is constant (and equal to the angle at the time of lock). The angular velocities are adjusted to be consistent with the constraints.

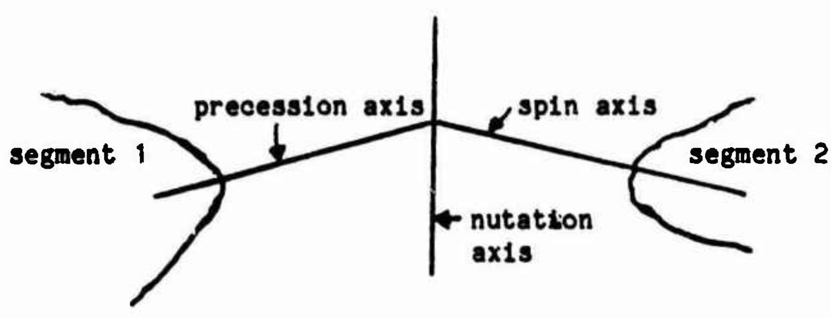

Figure 4-1 EULER JOINT

4.1.2 ALGORITHM FOR CORRECTING DRIFT

The mathematics involved in the drift correction algorithm may be illustrated by the case of a single free axis (i.e., a pin joint). The direction of this axis is fixed in each of the adjoining segments. With reference to Figure 4-2 let

$\underline{h}_1$ and $\underline{h}_2$ be the unit pin vectors (1 by 3 matrices), and

$\underline{D}_1$ and $\underline{D}_2$ be the direction cosine matices (3 by 3) in the segments.

Since the pin vectors represent the same axis they must obey the constraint equation:

$$\underline{D}_1^{-1}\,\underline{h}_1 = \underline{D}_2^{-1}\,\underline{h}_2$$

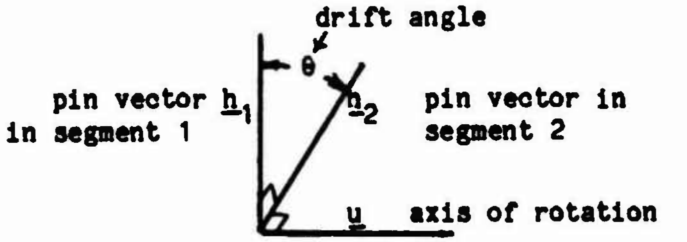

Figure 4-2 JOINT DRIFT MODEL

During the course of the integration the values of the $\underline{D}$'s will vary as the segments move but the $\underline{h}$'s are fixed. Errors in the integration process may then cause the above constraint equation to be violated. This may be corrected by adjusting the matrix $\underline{D}$ by a rotation about the axis defined by the cross-product of the $\underline{h}$'s. The sine of the rotation angle is the magnitude of this cross product. Define $\underline{u}$ by the equation (Figure 4-2)

$$\underline{u} = \underline{D}_2\,(\underline{D}_1^{-1}\underline{h}_1) \times (\underline{D}_2^{-1}\underline{h}_2)$$

and define the rotation matrix $\underline{R}$ as

$$\underline{R} = [\cos(\theta)\ \underline{I} + (1/(1 + \cos(\theta)))\underline{u}\underline{u}' + (\underline{u}\ x)].$$

In the expression for $\underline{R}$, $\underline{u}'$ is the transpose of the matrix $\underline{u}$, $(\underline{u}\ x)$ is the matrix analogous to a vector cross product operation, and θ is the rotation angle. (Note that $\underline{u}$ is not a unit vector). The direction cosine matrix of segment 2 is replaced by the direction cosine matrix $\underline{D}$ which is given by the matrix equation

$$\underline{D} = \underline{R}\ \underline{D}_2$$

In the case of an EULER joint with just the precession or the spin axis locked, the constraint is that the nutation axis must remain perpendicular to the locked axis. The mathematical relations are the same as given above except that the rotation angle is the complement of the angle between the vectors defining the axes. In the case of the EULER joint with just the nutation axis locked the relations are again the same as given above except that the rotation angle is such as to maintain a constant angle between the precession and the spin axis. A complete description of the EULER joint is given in Reference 35 and is illustrated in Figure 4-1 above.

4.1.3 ALGORITHM FOR CORRECTING VELOCITIES

After the direction cosine matrices have been modified it is necessary to correct the angular velocities to maintain consistency of the constraints. When the joint is fully locked (locked ball joint, locked pin joint, or EULER joint with all three axes locked) the angular velocity of segment 2 must be the same as the angular velocity of segment 1. The correction equation is

$$\underline{w}_2 = \underline{D}_2\ \underline{D}_1^{-1}\underline{w}_1$$

where $\underline{w}_1$ and $\underline{w}_2$ are the respective angular velocities of the segments.

For the case of a single free axis(pin joint or an EULER joint with two axes locked and one axis free) the equation is:

$$\underline{w}_2' = \underline{h}\underline{h}'\underline{w}_2 + (\underline{I} - \underline{h}\underline{h}')\underline{D}_2\underline{D}_1^{-1}\underline{w}_1$$

where $\underline{h}$ is the pin vector of the free axis, $\underline{h}'$ is its transpose and $\underline{I}$ is the identity matrix. Finally for the case of the EULER joint with only one axis locked the equation is

$$\underline{w}_2' = (\underline{I} - \underline{h}\underline{h}')\underline{w}_2 + \underline{h}\underline{h}' \underline{D}_2\underline{D}_1^{-1}\underline{w}_1$$

where h is a vector which is perpendicular to the the free axes and w_2' is the updated angular velocity of segment 2.

4.2 AUTOMATIC RELOCATION OF HARNESS POINTS

The current harness model requires that the user specify a set of potential reference points on the ellipsoids which are in contact with the belts comprising the harness. A typical configuration is shown in Figure 4-3. The reader is referred to the description of the harness algorithms in References 31 and 34 for more detail. The discussion below assumes the reader is familiar with the basic algorithms.

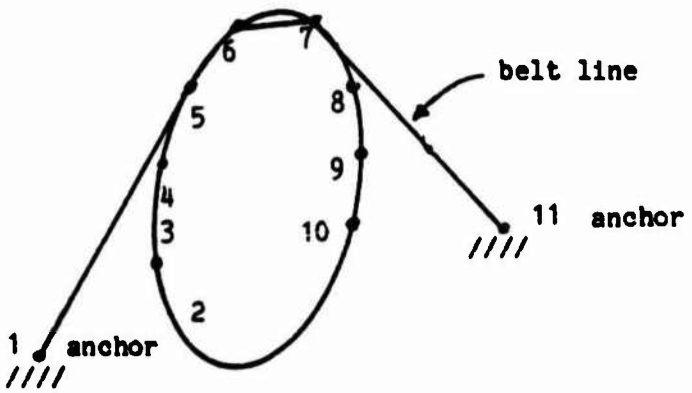

Figure 4-3 POINTS ON SAMPLE HARNESS

Note that points 2 thru 4 and points 8 thru 10 are not currently on the belt line. However at a later time as the ellipsoid moves some of them may be activated (included in the belt line). Since these points were specified initially, their current location with respect to the belt line may be unrealistic (make a jagged belt line) and thus cause undesirable strains to be computed during the succeeding time steps. To alleviate this problem a new procedure was added to the model to readjust any newly activated points so that they lie on the ellipsoid and in the plane determined by the adjoining currently active points, i.e., points 2 thru 4 in Figure 4-3, if they become activated, are adjusted to lie in the plane determined by points 1, 5 and 6, and points 8 thru 10, if they become activated, are adjusted to lie in the plane determined by points 6, 7 and 11. The code for this new procedure was inserted in Subroutine HBPLAY at the point where newly activated points are identified.

4.2.1 ELLIPSE ALGORITHM

The intersection of a plane with an ellipsoid is an ellipse. The plane vector, $\vec{t}$, defining a plane containing three non-colinear points p1, p2, and p3 may be determined by taking the vector (cross) product of the vector $\overrightarrow{(p3 - p2)}$ with the vector $\overrightarrow{(p2 - p1)}$ and normalizing to a unit magnitude, thus

$\vec{t} = \overrightarrow{(p3 - p2)} \times \overrightarrow{(p2 - p1)} / |\overrightarrow{(p3 - p2)} \times \overrightarrow{(p2 - p1)}|$, and

$d = \vec{t}'\vec{p1}$ is the distance to the plane, where the apostrophe ' is used to indicate the transpose of a vector or a matrix. If $\vec{u}$ and $\vec{v}$ are vectors $\vec{u}'\vec{v}$ is scalar which is the dot product of the vectors.

In the following mathematical developement we revert back to our matrix notation where $\underline{p}$, $\underline{q}$, and $\underline{t}$ are 3 by 1 matrices whose components indicate the location of the points in the coordinate system associated with the ellipsoid matrix $\underline{E}$. This is done to facilitate the notation in equations involving the ellipsoid matrix.

Let $\underline{q}$ be the projection of a point p onto the plane. Then

$\underline{q} = \underline{p} - \underline{t}\,\underline{t}'\underline{p} + d\,\underline{t}$.

The equations may be simplified with no restrictions by assuming the center of the ellipsoid is the origin of the coordinate system used in the calculations. A point $\underline{r}$ is on the ellipsoid if $\underline{r}'\underline{E}\underline{r} = 1$ where $\underline{E}$ is the symmetric matrix defining the ellipsoid. The center, $\underline{s}$, of the ellipse determined by the intersection of the plane with the ellipsoid is given by

$\underline{s} = b\,\underline{E}^{-1}\underline{t}$ where

$b = d/\ \underline{t}'\underline{E}^{-1}\underline{t}$.

If $\underline{r} = \underline{s} + a(\underline{q} - \underline{s})$ and the scalar a is selected such that $\underline{r}'\underline{E}\underline{r} = 1$ then $\underline{r}$ will be the point determined by projecting p onto the plane of the ellipse and then adjusting its radial position to move it to the surface of the ellipsoid. The value of a is given by

$a^2 = (b\,d - 1)/(b\,d - \underline{q}'\underline{E}\underline{q})$, where the positive value of a is used.

The geometry is illustrated in the Figure 4-4 below.

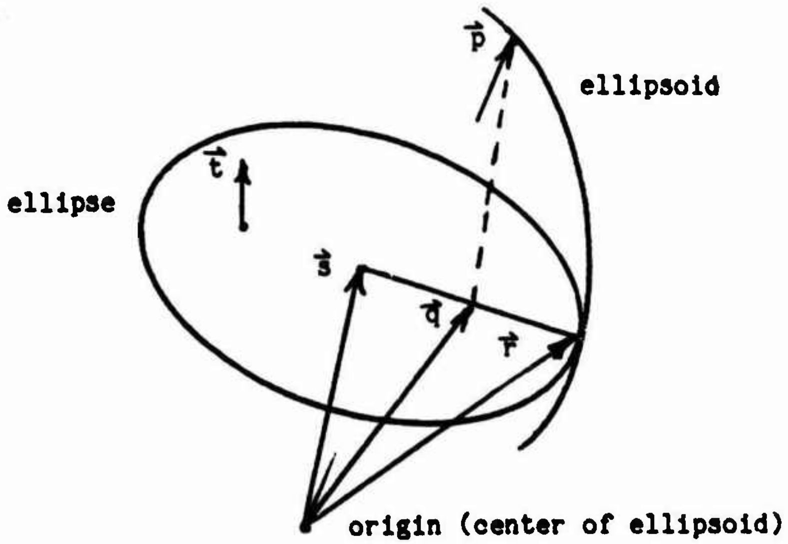

Figure 4-4 ELLIPSE GEOMETRY

4.3 INSTANTANEOUS DYNAMIC QUANTITIES

4.3.1 INTRODUCTION

The ATB Model allows the user to output complete information as to the kinematics of the individual segments and the various forces and torques (moments) which act on these segments. However, previous versions of the model allowed no outputs concerning the global properties of a set of segments connected by joints such as the instantaneous center of mass, the instantaneous linear and/or angular momentum of this set of segments. The ATB-III Model contains a new version of Subroutine OUTPUT which will allow these quantities to be outputted as specified on cards H.8.

4.3.2 CALCULATION OF GLOBAL OUTPUTS

The values of instantaneous center of mass (c.g.), linear momentum and angular momentum were added to the tabular time histories outputted by the ATB Model. To use this option the user must enter the segment numbers which are to be used in the computations and the segment number which is used to define the output reference system.

The formula for the instantaneous center of mass, z, is:

$$\underline{z} = \sum m_i \underline{z}_i \;/\; \sum m_i \quad \text{where,}$$

m_i is the mass of the i'th segment,

$\underline{z}_i$ is the location of the c.g. of the i'th segment, and

$\underline{z}$ is the location of the instantaneous center of mass.

The formula for the linear momentum, G, is:

$$\underline{G} = \sum m_i \dot{\underline{z}}_i \qquad \text{where,}$$

$\dot{\underline{z}}_i$ = is the linear velocity of the c.g. of segment i

The formula for the angular momemtum, $\underline{H}$, about the origin is:

$$\underline{H} = \sum [\underline{D}_i^{-1} \underline{P}_i \underline{w}_i + m_i \underline{z}_i \times \dot{\underline{z}}_i] \quad \text{where,}$$

$\underline{D}_i$ is the direction cosine matrix of the i'th segment,

$\underline{P}_i$ is the inertia matrix of the i'th segment, and

$\underline{w}_i$ is the angular velocity of the i'th segment.

In the above formulae for $\underline{z}$, $\underline{G}$ and $\underline{H}$, the summations are over the segment numbers inputted by the user. If the user has selected segment j for the output reference, then the c.g. of segment j is subtracted from the value of $\underline{z}$ and this relative value of $\underline{z}$ along with the values of $\underline{G}$ and $\underline{H}$ are multiplied by the direction cosine matrix associated with segment j before they are printed.

5.0 LONG-BONE INJURY PREDICTION

5.1 INTRODUCTION

The principal reason for developing simulation models such as the ATB Model is to evaluate the injury potential of particular dynamic situations. One type of potential injury is the fracturing of the extremities, i.e., the arms and the legs. In this section techniques for using the ATB Model (with modifications) for assessing maximum stresses in the long-bone structures of the arms and legs are discussed. In particular, techniques for estimating the maximum torque (bending and torsional moments) on a long-bone segment are described.

It will be shown that if the segment is considered as a slender rigid body of uniform cross section, such as a circular cylinder, that the forces and torques(moments) vary as a cubic polynomial function of the distance along the segment. Forces and torques are vector quantities and a cubic polynomial must be used for each component of the vectors.

5.2 EQUATIONS OF A SINGLE SEGMENT

The ATB Model treats each segment as a rigid body and writes the free body equations of motion of the segment. With reference to Figure 5-1 the free body equations of motion are:

$$
\begin{aligned}
m \ddot{\underline{x}} &+ \sum \underline{f}_i &&= \sum \underline{F}_j \\
(\underline{\Phi}\, \dot{\underline{w}}) &+ \sum \underline{r}_i \times \underline{Df}_i + \underline{t}_i &&= \sum \underline{R}_j \times \underline{DF}_j + \sum \underline{T}_i
\end{aligned}
\qquad (5.1)
$$

where:

		matrix size	reference
m	mass of segment	scalar 1 by 1	
$\underline{I}$	inertia matrix	3 by 3	local
$\ddot{\underline{x}}$	linear acceleration	1 by 3	inertial
$\underline{w}$	angular velocity	1 by 3	local
$\underline{f}_i$	constraint forces	1 by 3	inertial
$\underline{r}_i$	point of application of f_i	1 by 3	local
$\underline{t}_i$	constraint torques	1 by 3	local
$\underline{F}_j$	external forces	1 by 3	inertial
$\underline{R}_j$	point of application of F_j	1 by 3	local
$\underline{T}_i$	external torques	1 by 3	local
$\underline{D}$	direction cosine matrix for segment	3 by 3.	

As described in Reference 35, the notation we are using is a matrix notation not a true vector notation. However, we will sometimes refer to the 1 by 3 matrices as vectors. Time derivatives are denoted by dots over variables. The " x " is used to indicate the matrix operation analogous to the vector cross product. A more complete discussion of the mathematical notation and the techniques used for solving the equations may be found in Reference 35.

In this model the constraint forces are the forces at the joints which prevent the joints from separating and the constraint torques are the torques at the joints which impose pin or locking constraints.

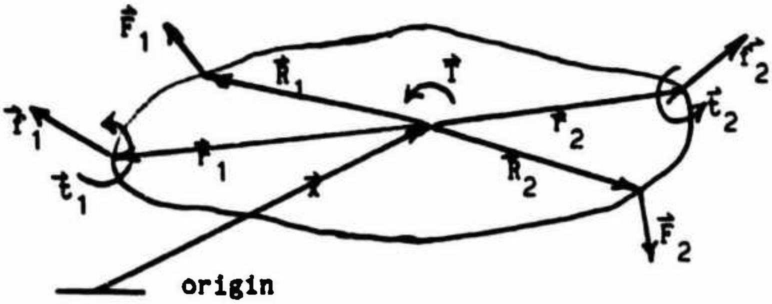

Figure 5-1 TYPICAL SEGMENT

5.3 TWO-SEGMENT APPROACH

CONSTRAINT EQUATIONS FOR A SLENDER BODY

In order to determine stress at points within a segment such a segment is considered to consist of two segments connected by a locked joint at the point of interest. The equations of motion of two rigid segments which are tied together at a locked joint as shown in Figure 5-2 are:

$$
\begin{aligned}
m_1\ddot{\underline{x}}_1 &+ \underline{f} &&= m_1\underline{g} + \underline{F}_1 \\
m_2\ddot{\underline{x}}_2 &- \underline{f} &&= m_2\underline{g} + \underline{F}_2 \\
(\dot{\underline{\Phi}_1\underline{w}}) &+ \underline{r}_1 \times \underline{D}_1\underline{f} + \underline{D}_1\underline{t} &&= \underline{T}_1 + \underline{R}_1 \times \underline{D}_1\underline{F}_1 \\
(\dot{\underline{\Phi}_2\underline{w}}) &- \underline{r}_2 \times \underline{D}_2\underline{f} - \underline{D}_2\underline{t} &&= \underline{T}_2 + \underline{R}_2 \times \underline{D}_2\underline{F}_2
\end{aligned}
\tag{5.2}
$$

subject to the constraint equations

$$
\begin{aligned}
\underline{x}_1 + \underline{D}_1^{-1}\underline{r}_1 &= \underline{x}_2 + \underline{D}_2^{-1}\underline{r}_2 \\
\underline{D}_1^{-1}\underline{D}_2 &= \text{a constant matrix}
\end{aligned}
\tag{5.3}
$$

where;

m_1 , m_2	mass of segments
$\underline{\Phi}_1$, $\underline{\Phi}_2$	inertia matrix of segments
$\ddot{\underline{x}}_1$, $\ddot{\underline{x}}_2$	linear acceleration of cg
$\underline{w}$	angular velocity
$\underline{f}$	constraint force at locked joint
$\underline{r}_1$, $\underline{r}_2$	location of locked joint
$\underline{t}$	constraint torque at locked joint
$\underline{g}$	acceleration of gravity
$\underline{F}_1$, $\underline{F}_2$	external forces
$\underline{R}_1$, $\underline{R}_2$	point of application of F
$\underline{T}_1$, $\underline{T}_2$	external torques
$\underline{D}_1$, $\underline{D}_2$	direction cosine matrices

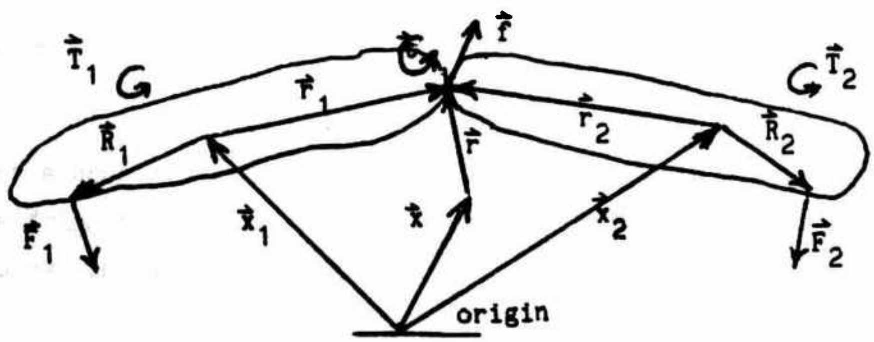

Figure 5-2 SLENDER BODY

All of the variables needed are available in the program at a particular point in time, hence the constraint force, $\underline{f}$ and the constraint torque, $\underline{t}$, are computed and may be printed at each point in time. Thus, this technique may be used to evaluate the integrated stresses at a particular point in any segment. The major difficulty with this technique is that the user must prespecify the position of the locked joint and may not know if this is the position of maximum stress.

5.4 MULTI-SEGMENT APPROACH

The equations for the single segment considered as two segments connected by a locked joint will now be derived. When considered as a single rigid body in dynamic equilibrium the equations of motion obtained by combining equations (5.2) are:

$$m\,\ddot{\underline{x}} = m\,\underline{g} + \underline{F}_1 + \underline{F}_2 \tag{5.4}$$

$$\dot{(\underline{\underline{\Phi}}\,\underline{w})} = \underline{T}_1 + \underline{T}_2 + (\underline{r} - \underline{r}_1 + \underline{R}_1) \times \underline{D}\,\underline{F}_1 + (\underline{r} - \underline{r}_2 + \underline{R}_2) \times \underline{D}\,\underline{F}_2$$

where;

$m = m_1 + m_2$ the total mass

$\underline{\underline{\Phi}} = \underline{\underline{\Phi}}_2 + \underline{\underline{\Phi}}_1 + J_1 + \underline{J}_2$ the total inertia

$\underline{J}_1 = m_1(\underline{s}'\underline{s}\,\underline{I} - \underline{s}\,\underline{s}')$ translated inertia $\underline{s} = \underline{r}_1 - \underline{r}$

$\underline{J}_2$	$=$	$m_2(\underline{s}'\underline{s}\ \underline{I} - \underline{s}\ \underline{s}')$	translated inertia $\underline{s} = \underline{r}_2 - \underline{r}$
$\underline{I}$			identity matrix
$\underline{x}$	$=$	$(m_1\ \underline{x}_1 + m_2\ \underline{x}_2)/m$	the cg of total body
$\underline{r}$	,	$\underline{r}_1$, $\underline{r}_2$	location of joint from cg's
$\underline{D}$			the direction cosine matrix

(Where the aposthrophe ' is used to indicate the transpose of a matrix.) Equations (5.2) may be solved for the constraint force $\underline{f}$ and the constraint torque $\underline{t}$ as:

$$m\,\underline{f} = m_2\ \underline{F}_1 - m_1\ \underline{F}_2 + m_1 m_2 [\underline{D}^{-1}(\ddot{\underline{r}}_1 - \underline{r}_2)]$$

$$2\underline{D}\ \underline{t} = \underline{T}_1 - \underline{T}_2 + \underline{R}_1 \times \underline{D}\ \underline{F}_1 - \underline{R}_2 \times \underline{D}\ \underline{F}_2 \qquad (5.5)$$

$$+ [(\underline{\Phi}_1 - \underline{\Phi}_2)\dot{\underline{w}}] - (\underline{r}_1 + \underline{r}_2) \times \underline{D}\ \underline{f}$$

All of the required quantities except the inertial constants related to the particular subdivision are available for any point of time in the ATB Model.

Although the equations presented above are valid for any cut of a rigid body it must be remembered that the forces in the uncut body are distributed as internal stresses over the area of the proposed cut. After the cut is made the integrated stresses are concentrated as forces at the joint position. For a slender body this yields a valid approximation to the desired breaking stresses. To more accurately determine the stress distribution would require a more elaborate technique such as a finite-element method.

Next consider a circular cylinder of uniform mass distribution which is divided into two pieces at the point z as illustrated in Figure 5-3. We have

a	length of cylinder
b	radius of cylinder
m	total mass
$\Phi_x = \Phi_y = m\,(b^2/4 + a^2/12)$	total inertia about x or y axes

$\Phi_Z =$	$m\, b^2/2$	total inertia about z axis
$m_1 =$	$m\, z / a$	mass of section 1
$m_2 =$	$m\, (1 - z / a)$	mass of section 2
$r_1 =$	$z / 2$	position of z from cg of 1
$r_2 =$	$(z - a / 2)$	position of z from cg of 2
$\Phi_{1x} = \Phi_{1y} =$	$m_1(b^2/4 + z^2/12)$	inertia of 1 about x,y
$\Phi_{1z} =$	$m_1 b^2/2$	inertia of 1 about z
$\Phi_{2x} = \Phi_{2y} =$	$m_2(b^2/4 + (a - z)^2/12)$	inertia of 2 about x,y
$\Phi_{2z} =$	$m_2 b^2/2$	inertia of 2 about z

Note that the inertia about the x or y axes exhibit the highest dependence on z, which is a cubic in z (the corresponding masses are linear in z). Thus the constraint force, $\underline{f}$, and the constraint torque, $\underline{t}$, given by equation (5.5) are cubic functions of z, the point of subdivision.

Hence if the force and the torque are evaluated at 4 or more points, cubic polynomials may be used to interpolate these functions at intermediate points. As a minimum the segment should be divided into 3 pieces connected by locked joints.

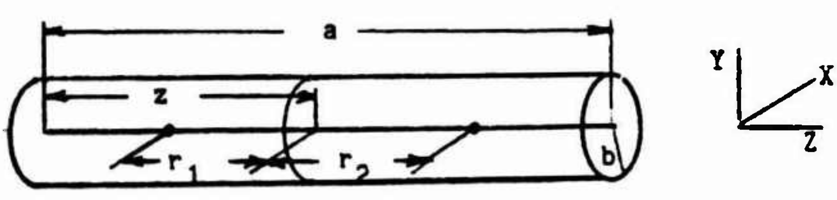

Figure 5-3 SEGMENTED CYLINDER

5.5 SUMMARY OF TECHNIQUES

Since the ATB Model has the capability of defining a locked-joint a possible method of evaluating the forces and moments at any point on a segment is to divide the segment into two pieces and lock the joint connecting the two pieces. The forces and moments at this joint are computed by the program and can be printed in the Main Output. This technique however will evaluate the forces and momentes at the specified joint which may not produce the peak values. But if one assumes a cubic variation as mentioned in the previous paragraph, dividing the segment into three pieces will produce four evaluations of the forces and moments (two at the interior joints and two at the exterior joints) thus providing enough information to evaluate the coefficients of the cubic polynomials defining the forces and moments at any point along the slender body. The only problem with utilizing this method is one of program size and running time.

APPENDIX A

LISTING OF INPUT DECKS

```
 19-MAY-82                                                                    CARD A1A
   95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
   AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
 IN  LB  SEC      0.          0.         386.088                              CARD A3
  6  40  .040  .000125   .004  .000125                                        CARD A4
0 0 0 2                                           1                           CARD A5
    2     1          SINGLE MAN(95%)-SEAT                                     CARD B1
 MS  M369.87238.63 223.871.688 144.0 6.94 35.68 -6.13 -0.12  9.51    1        CARD B21
                0.0 -19.41  0.0                                                    B22
 CH  C 25.0  25.0  20.0  25.0  38.4  38.4  38.4  0.00  0.00  0.00    0             B2B
NULL 0    0    0                                                              CARD B3A

                                                                              CARD B4A
                                                                              CARD B5A
 0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1         CARD B6A
 0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1              B6B
 AIRFRAME
0.    0.    0.    0.    1.                                                    CARD C2
    1     0     0     0     0     2     0     1     0     4                   CARD D1
  1      EJEC PLANE                                                           CARD D2A
  30.0        30.0       -100.0                                                   D2B
 -30.0         30.0       -100.0                                                   D2C
 -30.0        -30.0       -100.0                                                   D2D
                                                                              CARD D7
 1  2-12.73  6.00 -2.97176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0        CARD D8A
 1  2-12.73 -6.24 -2.97176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0             D8A
  1   1   0 -10.558    -0.120     9.858     0.00     40.75      0.00          CARD D9A
  1  -2   3  -3.620    -0.120    17.910     0.00     77.60      0.00               D9B
  1   4   0 -11.530    -2.616    -6.630     0.00    -30.00      0.00               D9C
  2   5   0   0.000     0.000     0.000     0.00    150.00      0.00               D9D
  1    SUSTAINER ROCKET                                                       CARD E1
  0.000       -1.600        0.000        0.000        0.000                        E2
   9                                                                               E4A
  0.000          0.0        0.213          0.0        0.214       3425.0           E4B
  0.243       3680.0        0.354       3400.0        0.494       3150.0           E4C
  0.605       1000.0        0.653          0.0        1.600          0.0           E4C
  2      STAPAC ROCKET                                                        CARD E1
  0.000       -1.600        0.000        0.000        0.000                        E2
  12                                                                               E4A
  0.000          0.0        0.198          0.0        0.199         23.4           E4B
  0.203        890.6        0.204        703.1        0.428        723.8           E4C
  0.698        492.2        0.742        515.6        0.755        445.3           E4D
  0.779         82.0        0.800          0.0        1.600          0.0           E4E
  3    STAPAC PITCH VS RATE                                                   CARD E1
 -6.283       -6.283        0.000        0.000        0.000                        E2
   4                                                                               E4A
 -6.283        -0.7854     -1.571        -0.7854      1.571        0.7854          E4B
  6.283         0.7854                                                             E4C
  4    DROGUE GUN ON SEAT                                                     CARD E1
  0.000       -1.600        0.000        0.000        0.000                        E2
   6                                                                               E4A
```

```
  0.000        0.0        0.211        0.0        0.212      1756.0        E4B
  0.216     1756.0        0.217        0.0        1.600         0.0        E4C
 5    DROGUE GUN ON CHUTE                                             CARD E1
  0.000     -1.600        0.000      0.000        0.000                    E2
  6                                                                        E4A
  0.000        0.0        0.211        0.0        0.212      2200.0        E4B
  0.216     2200.0        0.217        0.0        1.600         0.0        E4C
 6    CHUTE CA FUNCTION                                               CARD E1
  0.000     -1.600        0.000      0.000        0.000                    E2
  8                                                                        E4A
  0.000        0.0        0.213        0.0        0.355       0.030        E4B
  0.478       0.46        0.500       0.46        1.308       0.460        E4C
  1.316       0.00        1.600       0.00                                 E4D
51                                                                    CARD E1
41     WIND FORCE ON CHUTE                                            CARD E6A
                                                                           E6B
   2                                                                       E6C
   0.      0.                                                              E6D
   .001    -10.        0.         0.                                       E6E
                                                                      CARD F1
                                                                      CARD F3
                                                                      CARD F4A
 -1   1                                                               CARD F7A
  2  -2   3   1   6                                                        F7B
1.          1.         1.          0   0   0   0   1                  CARD G1
 3.92635    0.12     -10.61135   -98.7127   0.0    -527.5009          CARD G2
-178.01766  0.12      34.84606   -98.7127   0.0    -527.5009          CARD G2
 0.00       12.5       0.00                                           CARD G3
 0.00       12.5       0.00                                           CARD G3
     3     1     0.00        0.00        0.00                         CARD H1A
           1    -6.13       -0.12        9.51                              H1B
           2     0.00        0.00        0.00                              H1C
     3     1     0.00        0.00        0.00                         CARD H2A
           1    -6.13       -0.12        9.51                              H2B
           2     0.00        0.00        0.00                              H2C
     3     1     0.00        0.00        0.00                         CARD H3A
           1    -6.13       -0.12        9.51                              H3B
           2     0.00        0.00        0.00                              H3C
     2     1     2                                                    CARD H4
     2     1     2                                                    CARD H5
     2     1     2                                                    CARD H6
                                                                      CARD H7
                                                                      CARD H8
*EOR
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 19-MAY-82                                                                  CARD A1A
   95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
   AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
 IN  LB  SEC      0.         0.        386.088                             CARD A3
  6  40  .040  .000125   .004  .000125                                     CARD A4
 0 0 0 2                                               1                   CARD A5
    2     1         SINGLE MAN(95%)-SEAT                                   CARD B1
 MS  M369.87238.63 223.871.688 144.0 6.94 35.68 -6.13  0.00   9.51     1   CARD B21
               0.0 -19.41  0.0                                                  B22
 CH  C 25.0  25.0  20.0  25.0  38.4  38.4  38.4  0.00  0.00  0.00     0         B2B
NULL 0    0    0                                                           CARD B3A

                                                                           CARD B4A
                                                                           CARD B5A
 0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1     CARD B6A
 0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1          B6B
  AIRFRAME
 0.    0.    0.    0.    1.                                                CARD C2
    1     0     0     0     0     2     0     1     0     4                CARD D1
  1      EJEC PLANE                                                        CARD D2A
  30.0         30.0        -100.0                                               D2B
 -30.0         30.0        -100.0                                               D2C
 -30.0        -30.0        -100.0                                               D2D
                                                                           CARD D7
  1  2-12.73  6.12 -2.97176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0  CARD D8A
  1  2-12.73 -6.12 -2.97176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0       D8A
  1   1   0 -10.558     0.000      9.858     0.00     40.75      0.00     CARD D9A
  1  -2   3  -3.620     0.000     17.910     0.00     77.60      0.00          D9B
  1   4   0 -11.530     0.000     -6.630     0.00    -30.00      0.00          D9C
  2   5   0   0.000     0.000      0.000     0.00    150.00      0.00          D9D
  1    SUSTAINER ROCKET                                                    CARD E1
   0.000       -1.600       0.000       0.000       0.000                      E2
    9                                                                          E4A
   0.000          0.0       0.213         0.0       0.214      3425.0          E4B
   0.243       3680.0       0.354      3400.0       0.494      3150.0          E4C
   0.605       1000.0       0.653         0.0       1.600         0.0          E4C
  2      STAPAC ROCKET                                                     CARD E1
   0.000       -1.600       0.000       0.000       0.000                      E2
   12                                                                          E4A
   0.000          0.0       0.198         0.0       0.199        23.4          E4B
   0.203        890.6       0.204       703.1       0.428       723.8          E4C
   0.698        492.2       0.742       515.6       0.755       445.3          E4D
   0.779         82.0       0.800         0.0       1.600         0.0          E4E
  3    STAPAC PITCH VS RATE                                                CARD E1
  -6.283       -6.283       0.000       0.000       0.000                      E2
    4                                                                          E4A
  -6.283      -0.7854     -1.571     -0.7854      1.571       0.7854          E4B
   6.283       0.7854                                                          E4C
  4    DROGUE GUN ON SEAT                                                  CARD E1
   0.000       -1.600       0.000       0.000       0.000                      E2
    6                                                                          E4A
```

```
   0.000        0.0       0.211        0.0       0.212      1756.0         E4B
   0.216     1756.0       0.217        0.0       1.600         0.0         E4C
  5    DROGUE GUN ON CHUTE                                            CARD E1
   0.000     -1.600       0.000      0.000       0.000                     E2
    6                                                                      E4A
   0.000        0.0       0.211        0.0       0.212      2200.0         E4B
   0.216     2200.0       0.217        0.0       1.600         0.0         E4C
  6    CHUTE CA FUNCTION                                              CARD E1
   0.000     -1.600       0.000      0.000       0.000                     E2
    8                                                                      E4A
   0.000        0.0       0.213        0.0       0.355       0.030         E4B
   0.478       0.46       0.500       0.46       1.308       0.460         E4C
   1.316       0.00       1.600       0.00                                 E4D
  51                                                                  CARD E1
  41     WIND FORCE ON CHUTE                                          CARD E6A
                                                                           E6B
    2                                                                      E6C
    0.     0.                                                              E6D
    .001    -10.        0.        0.                                       E6E
                                                                      CARD F1
                                                                      CARD F3
                                                                      CARD F4A
  -1   1                                                              CARD F7A
   2  -2   3   1   6                                                       F7B
 1.          1.        1.          0   0   0   0   1                  CARD G1
  3.92635    0.00     -10.61135   -98.7127    0.0     -527.5009       CARD G2
-178.01766   0.00      34.84606   -98.7127    0.0     -527.5009       CARD G2
  0.00       12.5       0.00                                          CARD G3
  0.00       12.5       0.00                                          CARD G3
     3     1     0.00        0.00        0.00                         CARD H1A
           1    -6.13        0.00        9.51                              H1B
           2     0.00        0.00        0.00                              H1C
     3     1     0.00        0.00        0.00                         CARD H2A
           1    -6.13        0.00        9.51                              H2B
           2     0.00        0.00        0.00                              H2C
     3     1     0.00        0.00        0.00                         CARD H3A
           1    -6.13        0.00        9.51                              H3B
           2     0.00        0.00        0.00                              H3C
     2     1     2                                                    CARD H4
     2     1     2                                                    CARD H5
     2     1     2                                                    CARD H6
                                                                      CARD H7
                                                                      CARD H8
*EOR
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 20-MAY-82                                                                  CARD A1A
   5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
   AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
 IN  LB  SEC      0.          0.         386.088                            CARD A3
   6  40  .040  .000125   .004  .000125                                      CARD A4
 0 0 0 2                                                    1               CARD A5
    2     1         SINGLE MAN(5%)-SEAT                                     CARD B1
 MS  M298.80197.04186.1250.165 144.0 6.48 34.46 -5.04  0.11  8.14     1     CARD B2
             0.0 -20.84  0.0                                                     B22
 CH  C 25.0  25.0  20.0  25.0  38.4  38.4  38.4  0.00  0.00  0.00     0          B2B
NULL 0   0   0                                                              CARD B3A
 BLANK CARD
                                                                            CARD B4A
                                                                            CARD B5A
 0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1       CARD B6A
 0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1            B6B
  AIRFRAME
 0.    0.    0.    0.    1.                                                 CARD C2
    1     0     0     0     0     2     0     1     0     4                 CARD D1
   1      EJEC PLANE                                                        CARD D2A
   30.0        30.0      -100.0                                                  D2B
  -30.0        30.0      -100.0                                                  D2C
  -30.0       -30.0      -100.0                                                  D2D
                                                                            CARD D7
  1  2-11.64  6.23 -4.34176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0 CARD D8A
  1  2-11.64 -6.01 -4.34176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0      D8A
   1   1   0  -9.468     0.110     8.488     0.00     40.75      0.00       CARD D9A
   1  -2   3  -2.530     0.110    16.540     0.00     77.60      0.00            D9B
   1   4   0 -10.440    -2.386    -8.000     0.00    -30.00      0.00            D9C
   2   5   0   0.000     0.000     0.000     0.00    150.00      0.00            D9D
   1    SUSTAINER ROCKET                                                    CARD E1
    0.000      -1.600      0.000      0.000      0.000                           E2
     9                                                                           E4A
    0.000         0.0      0.213        0.0      0.214      3425.0               E4B
    0.243      3680.0      0.354     3400.0      0.494      3150.0               E4C
    0.605      1000.0      0.653        0.0      1.600         0.0               E4C
   2      STAPAC ROCKET                                                     CARD E1
    0.000      -1.600      0.000      0.000      0.000                           E2
    12                                                                           E4A
    0.000         0.0      0.198        0.0      0.199        23.4               E4B
    0.203       890.6      0.204      703.1      0.428       723.8               E4C
    0.698       492.2      0.742      515.6      0.755       445.3               E4D
    0.779        82.0      0.800        0.0      1.600         0.0               E4E
   3    STAPAC PITCH VS RATE                                                CARD E1
   -6.283      -6.283      0.000      0.000      0.000                           E2
     4                                                                           E4A
   -6.283       -0.7854    -1.571      -0.7854    1.571        0.7854            E4B
    6.283        0.7854                                                          E4C
   4    DROGUE GUN ON SEAT                                                  CARD E1
    0.000      -1.600      0.000      0.000      0.000                           E2
     6                                                                           E4A
```

```
  0.000        0.0       0.211        0.0       0.212     1756.0        E4B
  0.216     1756.0       0.217        0.0       1.600        0.0        E4C
 5    DROGUE GUN ON CHUTE                                          CARD E1
  0.000     -1.600       0.000      0.000       0.000                   E2
   6                                                                    E4A
  0.000        0.0       0.211        0.0       0.212     2200.0        E4B
  0.216     2200.0       0.217        0.0       1.600        0.0        E4C
 6    CHUTE CA FUNCTION                                            CARD E1
  0.000     -1.600       0.000      0.000       0.000                   E2
   8                                                                    E4A
  0.000        0.0       0.213        0.0       0.355      0.030        E4B
  0.478       0.46       0.500       0.46       1.308      0.460        E4C
  1.316       0.00       1.600       0.00                               E4D
51                                                                 CARD E1
41    WIND FORCE ON CHUTE                                          CARD E6A
                                                                        E6B
   2                                                                    E6C
   0.      0.                                                           E6D
   .001    -10.        0.         0.                                    E6E
                                                                   CARD F1
                                                                   CARD F3
                                                                   CARD F4A
 -1   1                                                            CARD F7A
  2  -2   3   1   6                                                     F7B
1.          1.         1.         0   0   0   0   1                CARD G1
 3.15871  -0.11      -9.03791  -122.4037     0.0     -634.3644     CARD G2
-178.01766 -0.11     34.84606  -122.4037     0.0     -634.3644     CARD G2
 0.00       12.5       0.00                                        CARD G3
 0.00       12.5       0.00                                        CARD G3
    3     1     0.00        0.00        0.00                       CARD H1A
          1    -5.04        0.11        8.14                            H1B
          2     0.00        0.00        0.00                            H1C
    3     1     0.00        0.00        0.00                       CARD H2A
          1    -5.04        0.11        8.14                            H2B
          2     0.00        0.00        0.00                            H2C
    3     1     0.00        0.00        0.00                       CARD H3A
          1    -5.04        0.11        8.14                            H3B
          2     0.00        0.00        0.00                            H3C
    2     1     2                                                  CARD H4
    2     1     2                                                  CARD H5
    2     1     2                                                  CARD H6
                                                                   CARD H7
                                                                   CARD H8
*EOR
```

```
 20-MAY-82                                                                    CARD A1A
   5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
   AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
 IN  LB  SEC      0.          0.         386.088                              CARD A3
  6  40  .040  .000125   .004  .000125                                        CARD A4
0 0 0 2                                                     1                 CARD A5
   2     1          SINGLE MAN(5%)-SEAT                                       CARD B1
MS  M298.80197.04186.1250.165 144.0 6.48 34.46 -5.04  0.00  8.14     1        CARD B2
               0.0 -20.84  0.0                                                     B22
CH  C 25.0  25.0  20.0  25.0  38.4  38.4  38.4  0.00  0.00  0.00    0              B2B
NULL 0   0   0                                                                CARD B3A
BLANK CARD
                                                                              CARD B4A
                                                                              CARD B5A
0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1          CARD B6A
0.    0.    0.    0.    0.    0.    .001  .1    .1    .001  .1    .1               B6B
 AIRFRAME
0.    0.    0.    0.    1.                                                    CARD C2
   1     0     0     0     0     2     0     1     0     4                    CARD D1
  1      EJEC PLANE                                                           CARD D2A
  30.0         30.0       -100.0                                                   D2B
 -30.0         30.0       -100.0                                                   D2C
 -30.0        -30.0       -100.0                                                   D2D
                                                                              CARD D7
 1  2-11.64  6.12 -4.34176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0        CARD D8A
 1  2-11.64 -6.12 -4.34176.47  0.00  0.00 40.00-120.0  0.0   0.0   0.0             D8A
  1   1   0  -9.468    0.000     8.488     0.00     40.75     0.00            CARD D9A
  1  -2   3  -2.530    0.000    16.540     0.00     77.60     0.00                 D9B
  1   4   0 -10.440    0.000    -8.000     0.00    -30.00     0.00                 D9C
  2   5   0   0.000    0.000     0.000     0.00    150.00     0.00                 D9D
  1     SUSTAINER ROCKET                                                      CARD E1
   0.000       -1.600       0.000        0.000        0.000                        E2
   9                                                                               E4A
   0.000          0.0       0.213          0.0        0.214       3425.0           E4B
   0.243       3680.0       0.354       3400.0        0.494       3150.0           E4C
   0.605       1000.0       0.653          0.0        1.600          0.0           E4C
  2       STAPAC ROCKET                                                       CARD E1
   0.000       -1.600       0.000        0.000        0.000                        E2
   12                                                                              E4A
   0.000          0.0       0.198          0.0        0.199         23.4           E4B
   0.203        890.6       0.204        703.1        0.423        723.8           E4C
   0.698        492.2       0.742        515.6        0.755        445.3           E4D
   0.779         82.0       0.800          0.0        1.600          0.0           E4E
  3     STAPAC PITCH VS RATE                                                  CARD E1
  -6.283       -6.283       0.000        0.000        0.000                        E2
   4                                                                               E4A
  -6.283      -0.7854      -1.571      -0.7854        1.571       0.7854           E4B
   6.283       0.7854                                                              E4C
  4     DROGUE GUN ON SEAT                                                    CARD E1
   0.000       -1.600       0.000        0.000        0.000                        E2
   6                                                                               E4A
```

```
   0.000        0.0       0.211        0.0       0.212      1756.0        E4B
   0.216     1756.0       0.217        0.0       1.600         0.0        E4C
  5    DROGUE GUN ON CHUTE                                           CARD E1
   0.000     -1.600       0.000      0.000       0.000                    E2
    6                                                                     E4A
   0.000        0.0       0.211        0.0       0.212      2200.0        E4B
   0.216     2200.0       0.217        0.0       1.600         0.0        E4C
  6    CHUTE CA FUNCTION                                             CARD E1
   0.000     -1.600       0.000      0.000       0.000                    E2
    8                                                                     E4A
   0.000        0.0       0.213        0.0       0.355       0.030        E4B
   0.478       0.46       0.500       0.46       1.308       0.460        E4C
   1.316       0.00       1.600       0.00                                E4D
 51                                                                  CARD E1
 41     WIND FORCE ON CHUTE                                          CARD E6A
                                                                          E6B
    2                                                                     E6C
    0.      0.                                                            E6D
    .001    -10.       0.       0.                                        E6E
                                                                     CARD F1
                                                                     CARD F3
                                                                     CARD F4A
 -1   1                                                              CARD F7A
  2  -2    3    1    6                                                    F7B
 1.          1.          1.         0   0   0   0   1                CARD G1
  3.15871    0.00     -9.03791   -122.4037    0.0     -634.3644      CARD G2
-178.01766   0.00     34.84606   -122.4037    0.0     -634.3644      CARD G2
  0.00       12.5      0.00                                          CARD G3
  0.00       12.5      0.00                                          CARD G3
     3    1    0.00      0.00      0.00                              CARD H1A
          1   -5.04      0.00      8.14                                   H1B
          2    0.00      0.00      0.00                                   H1C
     3    1    0.00      0.00      0.00                              CARD H2A
          1   -5.04      0.00      8.14                                   H2B
          2    0.00      0.00      0.00                                   H2C
     3    1    0.00      0.00      0.00                              CARD H3A
          1   -5.04      0.00      8.14                                   H3B
          2    0.00      0.00      0.00                                   H3C
     2    1    2                                                     CARD H4
     2    1    2                                                     CARD H5
     2    1    2                                                     CARD H6
                                                                     CARD H7
                                                                     CARD H8
*EOR
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APPENDIX B

OUTPUT LISTINGS

1 AFAMRL ARTICULATED TOTAL BODY (ATB-II) MODEL

DEVELOPED BY CALSPAN CORP., P.O. BOX 400, BUFFALO NY 14225
AND BY J & J TECHNOLOGIES INC., ORCHARD PARK NY 14127

FOR THE AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY,
AFSC AERONAUTICAL SYSTEMS DIVISION, WRIGHT-PATTERSON AFB
UNDER CONTRACTS F33615-75C-5002, -78C-0516 AND -80C-0511

AND FOR THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION,
U.S. DEPARTMENT OF TRANSPORTATION, UNDER CONTRACTS
FH-11-7592, HS-053-2-485, HS-6-01300 AND HS-6-01410.

PROGRAM DOCUMENTATION: NHTSA REPORT NOS. DOT-HS-801-507
THROUGH 510 (FORMERLY CALSPAN REPORT NO. ZQ-5180-L-1),
AVAILABLE FROM NTIS (ACCESSION NOS. PB-241692,3,4 AND 5),
APPENDIXES A-J TO THE ABOVE (AVAILABLE FROM CALSPAN),
AND REPORT NOS. AMRL-TR-75-14 AND AFAMRL-TR-80-14.

PROGRAM ATB-II, EXECUTED ON THE CDC CYBER COMPUTER SYSTEM,
AFSC ASD COMPUTER CENTER, WRIGHT-PATTERSON AFB, OHIO 45433

19-MAY-82 IRSIN= 0 IRSOUT= 0 RSTIME = 0.0000 CARDS A

95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

UNITL = IN UNITM = LB UNITT = SEC GRAVITY VECTOR = (0.0000, .0000, 386.0880)

NDINT = 6 NSTEPS = 40 DT = .040000 H0 = .000125 HMAX = .004000 HMIN = .000125

0 NPRT ARRAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

1 CRASH VICTIM   SINGLE MAN(95%)-SEAT   2 SEGMENTS   1 JOINTS   CARD B.1

CARDS B.2

SEGMENT			WEIGHT	PRINCIPAL MOMENTS OF INERTIA (LB - SEC**2- IN)			SEGMENT CONTACT ELLIPSOID SEMIAXES (IN)			CENTER (IN)			PRINCIPAL AXES (DEG)		
I	SYM	PLOT	(LB)	X	Y	Z	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL
1	MS	M	369.870	238.6300	223.8000	71.6880	144.000	6.940	35.680	-6.130	-.120	9.510	0.00	-19.41	0.00
2	CH	C	25.000	25.0000	20.0000	25.0000	38.400	38.400	38.400	0.000	0.000	0.000	0.00	0.00	0.00

CARDS B.3

JOINT					LOCATION(IN) - SEG(JNT)			LOCATION(IN) - SEG(J+1)			PRIN. AXIS(DEG) - SEG(JNT)			PRIN. AXIS(DEG) - SEG(J+1)		
J	SYM	PLOT	JNT	PIN	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL	YAW	PITCH	ROLL
1	NULL	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00

1 JOINT TORQUE CHARACTERISTICS

CARDS B.4

	FLEXURAL SPRING CHARACTERISTICS					TORSIONAL SPRING CHARACTERISTICS				
JOINT	SPRING COEF. (IN LB /DEG**J) LINEAR (J=1)	QUADRATIC (J=2)	CUBIC (J=3)	ENERGY DISSIPATION COEF.	JOINT STOP (DEG)	SPRING COEF. (IN LB /DEG**J) LINEAR (J=1)	QUADRATIC (J=2)	CUBIC (J=3)	ENERGY DISSIPATION COEF.	JOINT STOP (DEG)
1 NULL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CARDS B.5

JOINT VISCOUS CHARACTERISTICS AND LOCK-UNLOCK CONDITIONS

JOINT	VISCOUS COEFFICIENT (IN LB SEC/DEG)	COULOMB FRICTION COEF. (IN LB)	FULL FRICTION ANGULAR VELOCITY (DEG/ SEC)	MAX TORQUE FOR A LOCKED JOINT (IN LB)	MIN TORQUE FOR UNLOCKED JOINT (IN LB)	MIN. ANG. VELOCITY FOR UNLOCKED JOINT (RAD/ SEC)	IMPULSE RESTITUTION COEFFICIENT
1 NULL	0.000	0.00	0.00	0.00	0.00	0.00	0.000

SEGMENT INTEGRATION CONVERGENCE TEST INPUT

SEGMENT		ANGULAR VELOCITIES (RAD/ SEC)			LINEAR VELOCITIES (IN / SEC)			ANGULAR ACCELERATIONS (RAD/ SEC**2)			LINEAR ACCELERATIONS (IN / SEC**2)		
NO.	SYM	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR
1	MS	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000
2	CH	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000

1 VEHICLE DECELERATION INPUTS CARDS C

AIRFRAME

YAW	PITCH	ROLL	VIPS	VTIME	X0(X)	X0(Y)	X0(Z)	NATAB	AT0	ADT	MSEG
0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0	0.000000	0.000000	0

0 PASSENGER COMPARTMENT DISPLACEMENT HISTORY
ANALYTICAL HALF-SINE WAVE DECELERATION
V0= 0.000 IN / SEC, OBLIQUE ANGLES = 0.00 0.00 0.00 DEGREES, TIME DURATION = 1.000 SEC

1	NPL	NBLT	NBAG	NELP	NQ	NSD	NHRNSS	NWINDF	NJNTF	NFORCE
	1	0	0	0	0	2	0	1	0	4

CARD D.1

0 PLANE INPUTS

CARDS D.2

0 PLANE NO. 1 EJEC PLANE

	X	Y	Z
POINT 1	30.0000	30.0000	-100.0000
POINT 2	-30.0000	30.0000	-100.0000
POINT 3	-30.0000	-30.0000	-100.0000

0 BODY SEGMENT SYMMETRY INPUT

CARD D.7

SEG NO.	1	2
0 NSYM(J)	0	0

0 SPRING DAMPERS FUNCTION INPUT

CARDS D.8

COORDINATES OF ATTACHMENT POINTS (IN)

	SEGMENT		SEGMENT M			SEGMENT N			SPRING FORCE FUNCTION			DAMPING FORCE FUNCTION	
NO.	M	N	X	Y	Z	X	Y	Z	D0	A1	A2	B1	B2
1	1	2	-12.73	6.00	-2.97	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000
2	1	2	-12.73	-6.24	-2.97	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000

0 FORCE FUNCTIONS INPUT

CARDS D.9

NO.	SEG	FCN1	FCN2	X	Y	Z	YAW	PITCH	ROLL
1	1	1	0	-10.558	-.120	9.858	0.000	40.750	0.000
2	1	-2	3	-3.620	-.120	17.910	0.000	77.600	0.000
3	1	4	0	-11.530	-2.616	-6.630	0.000	-30.000	0.000
4	2	5	0	0.000	0.000	0.000	0.000	150.000	0.000

1FUNCTION NO. 1 SUSTAINER ROCKET NTI(1) = 1 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 9 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.214000	3425.0000
.243000	3680.0000
.354000	3400.0000
.494000	3150.0000
.605000	1000.0000
.653000	0.0000
1.600000	0.0000

0FUNCTION NO. 2 STAPAC ROCKET NTI(2) = 25 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 12 TABULAR POINTS

D	F(D)
0.000000	0.0000
.198000	0.0000
.199000	23.4000
.203000	890.6000
.204000	703.1000
.428000	723.9000
.698000	492.2000
.742000	515.6000
.755000	445.3000
.779000	82.0000
.800000	0.0000
1.600000	0.0000

1FUNCTION NO. 3 STAPAC PITCH VS RATE NTI(3) = 55 CARDS E

D0	D1	D2	D3	D4
-6.2830	-6.2830	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 4 TABULAR POINTS

D	F(D)
-6.283000	-.7854
-1.571000	-.7854
1.571000	.7854
6.283000	.7854

0FUNCTION NO. 4 DROGUE GUN ON SEAT NTI(4) = 69 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	1756.0000
.216000	1756.0000
.217000	0.0000
1.600000	0.0000

1FUNCTION NO. 5 DROGUE GUN ON CHUTE NTI(5) = 97 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.3000
.211000	0.0000
.212000	2200.0000
.216000	2200.0000
.217000	0.0000
1.600000	0.0000

0FUNCTION NO. 6 CHUTE CA FUNCTION NTI(6) = 105 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 8 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.355000	.0300
.478000	.4600
.500000	.4600
1.308000	.4600
1.316000	0.0000
1.600000	0.0000

1 WIND FORCE FUNCTION NO. 41   WIND FORCE ON CHUTE   NTI(41) = 127

D0	D1	D2	D3	D4
0.0000	0.0000	0.0000	0.0000	0.0000

0 WIND FORCE TABLES FOR   2 TIME POINTS.

T	FX(T)	FY(T)	FZ(T)
0.000000	0.	0.	0.
.001000	-10.0000	0.	0.

1 ALLOWED CONTACTS AND ASSOCIATED FUNCTIONS

1 SEGMENT WIND FORCES

SEGMENT-ELLIPSOID	SEGMENT-PLANE	WIND FORCE FUNCTION
2 - -2	3 - 1	6
CH	VEH - EJEC PLANE	CHUTE CA FUNCTION

1 SUBROUTINE INITAL INPUT CARD G.1

ZPLT(X)	ZPLT(Y)	ZPLT(Z)	I1	J1	I2	J2	I3	SPLT(1)	SPLT(2)	SPLT(3)
1.	1.	1.	0	0	0	0	1	10.00	6.00	1.00

0 INITIAL POSITIONS (INERTIAL REFERENCE) CARDS G.2

SEGMENT		LINEAR POSITION (IN)			LINEAR VELOCITY (IN / SEC)		
NO.	SEG	X	Y	Z	X	Y	Z
1	MS	3.92635	.12000	-10.61135	-98.71270	0.00000	-527.50090
2	CH	-178.01766	.12000	34.84606	-98.71270	0.00000	-527.50090

0 INITIAL ANGULAR ROTATION AND VELOCITY CARDS G.3

SEGMENT		ANGULAR ROTATION (DEG)			ANGULAR VELOCITY (DEG/ SEC)			IYPR			
NO.	SEG	YAW	PITCH	ROLL	X	Y	Z				
1	MS	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0
2	CH	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0

```
1    TIME        MACH    ALPHA     BETA          CX         CY        CZ           CL        CM         CN


 CARD H.1  3      1  1  2
 CARD H.2  3      1  1  2
 CARD H.3  3      1  1  2
 CARD H.4  2      1  2
 CARD H.5  2      1  2
 CARD H.6  2      1  2
 CARD H.7  0      0
   214.00        .9019    10.36     -.01      -8289.26      1.62    1997.30      -257.48 -60958.73   -982.06
   240.00        .8845     5.11     -.33      -8344.26     41.78    2537.85      -833.27 -63938.93   -621.88
   280.00        .8647   -19.73     -.35      -8128.37     -4.86    3233.14      -476.85 -38386.29   -807.68
0 DINT CONV. TEST   288.000   CH   ANG ACC   4983.        8829.       .2215       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .288000 FOR H =   .004000
   320.00        .8589   -54.89      .02      -6121.26       .11    4391.19      -535.75   1326.26   -729.39
   360.00        .8599   -83.97     -.12      -2444.65     11.62    3874.64      -405.93   -302.54   -339.66
   400.00        .8466   -94.62     -.83       -355.68    155.39    3047.81     -1247.09  -4498.20    -38.02
0 DINT CONV. TEST   420.000   CH   ANG ACC   .1008E+07   .3447E+06   .1260E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .420000 FOR H =   .004000
   440.00        .8258   -83.89    -1.43      -2272.50    131.81    3576.24       246.99   -155.50   -766.73
0 DINT CONV. TEST   468.000   CH   ANG ACC   .4127E+07   .7947E+07   1.900       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .468000 FOR H =   .004000
0 DINT CONV. TEST   472.000   CH   ANG ACC   .1506E+08   .1545E+07   .9874E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .472000 FOR H =   .004000
   480.00        .8088   -31.24     2.16      -7017.76    -88.66    3314.54      -684.55 -21676.48  -1682.15
0 DINT CONV. TEST   480.000   CH   ANG ACC   .3346E+08   .3178E+07   .9496E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .480000 FOR H =   .004000
0 DINT CONV. TEST   484.000   CH   ANG ACC   .1268E+05   .2240E+06   4.824       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .484000 FOR H =   .004000
0 DINT CONV. TEST   496.000   CH   ANG ACC   .3853E+06   .6919E+06   .1640       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .496000 FOR H =   .004000
0 DINT CONV. TEST   500.000   CH   ANG ACC   .8921E+07   .4628E+06   .5091E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .500000 FOR H =   .004000
0 DINT CONV. TEST   508.000   CH   ANG ACC   .7070E+07   .1971E+06   .2609E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .508000 FOR H =   .004000
0 DINT CONV. TEST   512.000   CH   ANG ACC   .1069E+06   .2634E+05   .2047       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .512000 FOR H =   .004000
   520.00        .7560    41.80     4.28      -3065.65  -1005.16  -2400.38      8048.73 -10209.97  -3374.23
0 DINT CONV. TEST   524.000   CH   ANG ACC   .6349E+07   .5949E+06   .9341E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .524000 FOR H =   .004000
0 DINT CONV. TEST   528.000   CH   ANG ACC   .2119E+06   6745.        .2976E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .528000 FOR H =   .004000
0 DINT CONV. TEST   540.000   CH   ANG ACC   .7405E+06   .1499E+06   .1912       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .540000 FOR H =   .004000
0 DINT CONV. TEST   548.000   CH   ANG ACC   .1029E+07   .1060E+05   .1027E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .548000 FOR H =   .004000
0 DINT CONV. TEST   556.000   CH   ANG ACC   3874.        .2039E+05   2.413       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =     .556000 FOR H =   .004000
   560.00        .6895    77.69    -1.74        -63.38     64.80  -3309.38      2306.31  25360.69     73.66
   600.00        .6458    74.97    -2.01       -427.40    157.64  -2825.78      2352.28  20780.13    110.99
   640.00        .6046    45.67     2.76      -1199.06    -71.88  -1502.90        44.64  -4440.56   -771.61
   680.00        .5703     -.80     4.53      -3093.46   -229.35   1177.47      2093.67 -25203.45  -1774.40
   720.00        .5515   -39.66     -.78      -2498.82     10.14   1375.63        29.28  -4427.32   -270.94
```

760.00	.5337	-49.81	-4.60	-2147.39	-52.91	1339.60	722.13	-269.32	-826.30
800.00	.5162	-34.24	-4.18	-2330.79	81.01	1187.37	492.53	-6583.46	91.77
840.00	.4990	-4.12	3.89	-2263.76	-45.55	796.89	663.76	-16717.71	-1169.55
880.00	.4748	25.73	9.48	-1620.83	-460.30	-116.83	3496.42	-12308.76	-1999.26
920.00	.4520	45.07	4.75	-750.24	-72.29	-802.41	86.50	-2916.55	-764.71
960.00	.4329	51.69	-2.60	-433.03	13.66	-883.63	666.18	-349.72	-7.44
1000.00	.4151	46.08	-5.39	-623.09	71.87	-692.55	197.06	-2194.92	481.13
1040.00	.3982	29.89	-1.33	-847.67	41.21	-277.85	-145.28	-6370.17	-47.58
1080.00	.3827	6.97	5.37	-1322.86	-103.48	375.32	808.05	-10774.43	-885.71
1120.00	.3703	-17.42	6.71	-1271.90	-23.63	528.23	591.80	-6684.81	-650.35
1160.00	.3612	-35.53	2.34	-1123.62	-20.25	582.35	-277.48	-2876.40	-220.89
1200.00	.3526	-43.67	-2.87	-989.94	4.66	586.77	154.67	-1154.60	-96.47
1240.00	.3442	-41.41	-6.65	-987.98	39.91	553.62	219.46	-1568.40	-30.20
1280.00	.3365	-29.87	-7.14	-1016.78	66.47	489.98	-138.18	-3568.97	207.15
1320.00	.3289	-12.47	-2.17	-970.32	-7.42	387.24	-143.68	-6141.84	8.90
1360.00	.3242	5.18	6.73	-1001.39	-104.22	314.46	978.24	-8264.58	-854.00
1400.00	.3197	19.94	17.59	-938.57	-380.61	108.31	3771.23	-7208.38	-2012.20
1440.00	.3155	33.17	30.51	-762.61	-638.74	-57.01	6146.44	-4673.86	-2529.78
1480.00	.3118	48.40	45.48	-451.68	-888.44	-180.81	7808.02	-1136.57	-2963.91
1520.00	.3140	89.59	62.76	58.48	-690.93	-411.83	6334.83	3493.40	-1736.68
1560.00	.3092	159.25	44.75	670.94	-715.55	-226.79	5904.70	1070.98	67.57
1600.00	.3028	176.46	4.06	688.85	16.40	-104.63	653.30	1007.62	-277.32

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT LINEAR ACCELERATIONS (G'S) IN LOCAL REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-6.13, -.12, 9.51) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
40.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
80.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
120.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
160.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
200.000	-.077	0.000	.342	.351	-.071	-.002	.350	.357	-.216	0.000	.976	1.000
240.000	-14.598	.112	-7.512	16.418	-17.906	.217	-13.655	22.519	-8.605	0.000	-.449	8.616
280.000	-14.388	-.017	-5.463	15.391	-12.218	.093	-11.621	16.862	-20.402	0.000	-.303	20.405
320.000	-10.020	.002	-.855	10.056	-3.897	.167	-3.497	5.239	-29.737	-.050	-6.220	30.381
360.000	2.817	.133	8.640	9.089	8.507	.279	11.609	14.395	59.416	.213	-43.508	73.643
400.000	8.539	.691	10.834	13.812	12.526	.965	15.955	20.308	-66.946	.648	-41.492	78.764
440.000	-2.710	1.185	24.722	24.899	8.983	2.002	33.929	35.155	1.738	1.180	8.313	8.574
480.000	-42.770	-1.562	12.381	44.553	-9.582	-2.036	-.036	9.796	-24.574	1.767	42.516	49.139
520.000	-23.527	-5.551	-40.724	47.357	-16.419	-7.369	-65.550	67.975	3.940	-2.329	45.027	45.259
560.000	.266	1.290	-38.575	38.598	-6.514	2.173	-49.172	49.650	-67.183	-2.145	-21.430	70.550
600.000	-3.005	1.844	-31.115	31.314	-6.728	3.055	-38.485	39.188	-38.406	2.594	-36.985	53.383
640.000	-16.861	-.735	-18.839	25.293	-13.127	-.495	-28.596	31.469	-20.107	6.542	-29.186	36.040
680.000	-27.789	-1.773	2.562	27.963	-17.014	-2.310	-3.647	17.553	-12.007	5.887	-14.087	19.423
720.000	-19.455	.613	13.357	23.607	-10.467	1.347	18.543	21.335	-23.411	.826	3.742	23.723
760.000	-16.221	1.315	12.420	20.473	-11.521	2.759	18.373	21.861	-35.379	-2.353	13.405	37.906
800.000	-18.095	1.471	8.913	20.225	-11.951	1.835	11.142	16.441	-21.790	-2.059	12.351	25.131
840.000	-19.565	-.765	1.076	19.609	-14.444	-2.284	-2.776	14.885	-12.827	-1.410	8.332	15.360
880.000	-15.254	-2.929	-6.999	17.037	-14.569	-5.233	-12.187	19.732	-11.848	-1.546	2.722	12.254
920.000	-9.442	-.458	-10.287	13.970	-11.076	-1.011	-14.135	17.986	-17.414	-1.426	-3.617	17.842
960.000	-7.395	1.437	-10.242	12.714	-9.723	2.339	-13.407	16.725	-14.056	.057	-7.288	15.833
1000.000	-8.291	2.056	-8.306	11.915	-9.729	3.472	-11.381	15.369	-14.550	2.583	-7.194	16.436
1040.000	-10.389	1.133	-4.841	11.517	-9.802	1.996	-7.850	12.715	-10.256	4.884	-4.720	12.302
1080.000	-12.719	-.435	-.033	12.727	-10.359	-.808	-2.312	10.644	-6.404	5.570	-1.846	8.686
1120.000	-11.173	-.342	3.654	11.760	-7.888	-1.119	3.476	8.692	-11.095	3.770	.572	11.732
1160.000	-8.987	.334	5.483	10.533	-6.120	.135	7.234	9.477	-12.119	.756	2.215	12.343
1200.000	-7.487	1.070	5.758	9.506	-5.285	1.548	8.293	9.955	-12.466	-1.610	3.021	12.927
1240.000	-7.219	1.582	4.969	8.906	-5.250	2.457	7.052	9.129	-12.153	-2.559	3.160	12.815
1280.000	-7.779	1.708	3.559	8.723	-5.617	2.417	4.447	7.561	-9.763	-2.384	3.052	10.504
1320.000	-7.564	1.004	1.509	7.778	-5.520	.931	.793	5.654	71.760	.109	.822	71.764
1360.000	-3.090	.602	.296	3.162	-2.251	.477	-1.429	2.708	-.074	-.002	.997	1.000
1400.000	-2.989	-.204	-.301	3.011	-2.369	-.311	-1.597	2.874	-.055	-.002	.998	1.000
1440.000	-2.606	-1.033	-.722	2.894	-1.826	-1.293	-1.462	2.673	-.037	-.002	.999	1.000
1480.000	-1.351	-.700	-.289	1.549	.137	.033	-.127	.190	-21.808	-2.305	-.713	21.941
1520.000	-.616	.653	-.175	.914	5.100	2.783	1.173	5.927	-40.467	-2.526	1.537	40.574
1560.000	1.263	-2.580	-.373	2.896	7.854	-3.641	-.245	8.660	-.001	-.004	1.000	1.000
1600.000	1.882	-.889	-.006	2.082	8.625	-1.068	-.423	8.701	-.025	-.001	1.000	1.000

1 DATE: 19-MAY-82

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT LINEAR VELOCITIES (IN / SEC) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-6.13, -.12, 9.51) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-98.713	0.000	-527.501	536.658	-98.713	0.000	-527.501	536.658	-98.713	0.000	-527.501	536.658
40.000	-98.713	0.000	-512.057	521.485	-98.713	0.000	-512.057	521.485	-98.713	0.000	-512.057	521.485
80.000	-98.713	0.000	-496.614	506.329	-98.713	0.000	-496.614	506.329	-98.713	0.000	-496.614	506.329
120.000	-98.713	0.000	-481.170	491.192	-98.713	0.000	-481.170	491.192	-98.713	0.000	-481.170	491.192
160.000	-98.713	0.000	-465.727	476.073	-98.713	0.000	-465.727	476.073	-98.713	0.000	-465.727	476.073
200.000	-98.713	0.000	-450.450	461.140	-98.711	-.001	-450.449	461.138	-98.713	0.000	-450.283	460.976
240.000	-255.920	.131	-508.384	569.165	-306.392	-.722	-558.192	636.754	-316.079	0.000	-487.487	580.990
280.000	-467.140	-.755	-621.075	777.145	-523.927	-.437	-765.141	927.330	-540.516	0.000	-462.979	711.693
320.000	-620.298	-1.520	-769.291	988.221	-583.904	1.225	-933.249	1100.863	-934.017	-.126	-454.439	1038.702
360.000	-688.094	-.746	-823.095	1072.827	-616.368	3.187	-903.998	1094.136	-1015.997	-.474	-609.937	1185.020
400.000	-846.509	.715	-701.132	1099.165	-840.728	5.257	-705.349	1097.437	-1230.621	1.932	-1334.356	1815.196
440.000	-1101.070	7.262	-611.957	1259.722	-1187.392	12.862	-520.936	1296.703	-2032.171	9.953	-1622.523	2600.461
480.000	-1621.516	26.912	-675.325	1764.515	-1561.521	-6.259	-317.052	1593.396	-2037.347	32.856	-1114.821	2322.646
520.000	-2335.734	40.425	-820.866	2476.108	-2036.127	15.203	-798.477	2187.147	-2022.979	27.518	-309.756	2046.741
560.000	-3005.218	57.095	-930.186	3146.401	-2947.741	43.912	-969.186	3103.293	-2561.526	-13.786	-168.794	2567.119
600.000	-3530.949	84.526	-983.051	3666.216	-3603.723	67.406	-946.503	3726.557	-3521.252	-8.299	-567.097	3566.635
640.000	-3956.906	103.664	-985.097	4079.003	-4154.223	112.808	-984.415	4270.757	-4005.222	61.562	-1020.399	4133.619
680.000	-4354.296	95.678	-915.450	4450.517	-4515.977	140.184	-1075.680	4644.436	-4327.483	158.309	-1299.330	4521.109
720.000	-4751.334	101.217	-867.220	4830.889	-4763.680	122.996	-995.900	4868.223	-4569.320	204.656	-1333.155	4764.228
760.000	-5079.078	112.733	-868.025	5153.951	-5080.220	98.760	-855.207	5152.647	-5043.987	176.012	-1116.201	5169.013
800.000	-5390.713	129.244	-883.087	5464.095	-5370.606	86.001	-769.101	5426.077	-5463.853	132.854	-866.007	5533.653
840.000	-5697.145	140.835	-865.021	5764.162	-5588.458	84.275	-751.411	5639.378	-5715.145	103.927	-684.242	5756.898
880.000	-5984.193	133.402	-819.607	6041.532	-5865.362	96.259	-794.241	5919.676	-5875.935	80.049	-583.360	5905.365
920.000	-6218.637	132.414	-788.777	6269.860	-6157.509	107.984	-806.168	6210.997	-6112.613	55.000	-568.156	6139.207
960.000	-6420.096	144.317	-762.458	6466.823	-6420.485	127.799	-776.699	6468.556	-6367.917	41.581	-624.228	6398.574
1000.000	-6607.603	152.124	-730.761	6649.629	-6665.247	150.016	-732.579	6707.063	-6600.955	58.044	-704.280	6638.674
1040.000	-6782.320	153.395	-692.165	6819.273	-6377.669	184.002	-701.685	6915.819	-6818.849	109.472	-761.227	6862.081
1080.000	-6963.314	142.331	-645.863	6994.651	-7054.589	206.367	-688.293	7091.090	-6945.669	186.221	-790.578	6992.998
1120.060	-7149.537	136.254	-602.007	7176.131	-7200.044	201.967	-672.094	7234.164	-7084.178	251.255	-777.399	7131.133
1160.000	-7318.712	143.611	-573.446	7342.548	-7331.374	177.970	-635.571	7361.024	-7265.548	273.845	-727.794	7307.042
1200.000	-7471.111	155.984	-554.936	7493.316	-7471.438	152.215	-583.667	7495.747	-7446.110	256.062	-662.108	7479.874
1240.000	-7611.434	169.448	-541.951	7632.585	-7609.562	135.628	-531.160	7629.283	-7631.259	215.641	-591.398	7657.177
1280.000	-7746.030	182.551	-528.092	7766.156	-7730.122	128.245	-484.298	7746.340	-7794.807	172.816	-525.478	7814.411
1320.000	-7876.993	189.890	-509.736	7895.753	-7829.887	129.011	-454.562	7844.132	-7655.106	147.826	-496.508	7672.615
1360.000	-7937.715	189.671	-488.753	7955.009	-7872.783	148.223	-449.081	7886.974	-7394.655	152.326	-503.865	7413.367
1400.000	-7980.832	183.684	-467.622	7996.629	-7913.464	164.444	-441.170	7927.457	-7394.655	152.326	-488.422	7412.333
1440.000	-8021.257	174.598	-450.069	8035.771	-7954.788	170.679	-435.093	7968.507	-7394.655	152.326	-472.978	7411.332
1480.000	-8059.142	164.421	-435.137	8072.555	-7990.444	169.047	-435.088	8004.066	-7431.547	146.491	-460.300	7447.229
1520.000	-8041.973	159.711	-422.017	8054.622	-7924.891	183.981	-465.919	7940.707	-8252.083	135.275	-428.778	8264.323
1560.000	-8071.565	155.902	-413.814	8083.669	-7999.447	184.791	-541.586	8019.888	-8390.429	138.391	-397.194	8400.965
1600.000	-8105.449	145.545	-397.518	8116.496	-8132.348	171.504	-549.139	8152.672	-8394.021	151.979	-389.256	8404.416

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT LINEAR DISPLACEMENTS (IN) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-6.13, -.12, 9.51) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	3.926	.120	-10.611	11.315	-.000	0.000	-.000	.000	-178.018	.120	34.846	181.396
40.000	-.022	.120	-31.403	31.403	-3.949	0.000	-20.791	21.163	-181.966	.120	14.055	182.508
80.000	-3.971	.120	-51.576	51.729	-7.897	0.000	-40.965	41.719	-185.915	.120	-6.119	186.015
120.000	-7.919	.120	-71.132	71.571	-11.846	0.000	-60.520	61.669	-189.863	.120	-25.674	191.591
160.000	-11.868	.120	-90.070	90.848	-15.794	0.000	-79.458	81.013	-193.812	.120	-44.612	198.880
200.000	-15.816	.120	-108.390	109.538	-19.743	0.000	-97.778	99.752	-197.760	.120	-62.932	207.532
240.000	-21.806	.121	-127.233	129.088	-26.624	-.013	-116.996	119.987	-206.753	.120	-82.082	222.451
280.000	-36.496	.119	-149.594	153.982	-45.045	-.022	-142.183	149.148	-22[illegible].276	.120	-101.115	245.105
320.000	-58.576	.067	-177.426	186.846	-69.809	-.050	-176.070	189.404	-252.249	.116	-119.818	279.259
360.000	-84.585	.020	-209.830	226.238	-95.066	-.018	-214.096	234.253	-296.143	.112	-139.219	327.235
400.000	-115.165	.011	-240.648	266.785	-124.559	.054	-246.954	276.589	-333.675	.134	-179.023	378.666
440.000	-153.369	.155	-266.602	307.569	-163.686	.240	-271.247	316.809	-403.713	.333	-238.927	469.117
480.000	-206.841	.738	-292.054	357.882	-216.805	.056	-286.736	359.474	-482.863	1.186	-296.663	566.716
520.000	-285.891	2.305	-322.404	430.911	-283.058	.632	-311.578	420.955	-565.594	2.584	-324.444	652.048
560.000	-393.125	4.151	-357.795	531.584	-384.331	2.687	-350.827	520.382	-653.294	2.814	-331.088	732.407
600.000	-524.226	6.954	-396.167	657.122	-515.805	4.935	-388.884	645.995	-776.401	2.157	-344.995	849.603
640.000	-674.303	10.769	-435.657	802.869	-670.647	7.698	-425.399	794.223	-927.798	3.031	-377.116	1001.516
680.000	-840.386	14.809	-473.892	964.905	-845.440	11.966	-464.176	964.557	-1095.047	7.460	-424.191	1174.360
720.000	-1022.672	18.705	-509.320	1142.635	-1032.941	17.069	-504.858	1149.844	-1272.573	15.001	-477.830	1359.408
760.000	-1219.478	22.964	-543.878	1335.461	-1230.435	21.328	-541.575	1344.518	-1464.231	22.775	-527.322	1556.457
800.000	-1428.876	27.799	-578.982	1541.973	-1438.746	24.741	-574.370	1549.355	-1675.097	28.916	-566.790	1768.626
840.000	-1650.678	33.240	-614.085	1761.518	-1656.379	28.059	-605.796	1763.906	-1899.104	33.611	-597.543	1991.176
880.000	-1884.460	38.763	-647.764	1993.061	-1884.443	32.377	-638.423	1989.914	-2130.959	37.294	-622.608	2220.364
920.000	-2128.673	44.007	-679.902	2235.051	-2124.943	37.392	-671.514	2228.837	-2370.391	39.988	-645.364	2457.000
960.000	-2381.512	49.534	-710.925	2485.853	-2376.630	42.782	-703.269	2478.868	-2620.164	41.847	-669.026	2704.553
1000.000	-2642.111	55.484	-740.814	2744.565	-2638.328	48.210	-733.016	2738.688	-2879.492	43.722	-695.627	2962.648
1040.000	-2909.938	61.623	-769.295	3010.540	-2909.292	53.949	-761.005	3007.660	-3148.126	46.960	-725.029	3230.878
1080.000	-3184.791	67.567	-796.082	3283.474	-3188.532	60.586	-788.000	3285.019	-3423.642	52.834	-756.174	3506.553
1120.000	-3467.102	73.071	-820.998	3563.731	-3474.818	67.927	-814.515	3569.651	-3704.007	61.697	-787.691	3787.339
1160.000	-3756.524	78.642	-844.461	3851.074	-3766.471	75.252	-840.266	3859.795	-3990.978	72.351	-817.875	4074.563
1200.000	-4052.371	84.628	-867.004	4144.945	-4063.038	81.825	-864.475	4154.791	-4285.200	83.060	-845.707	4368.645
1240.000	-4354.053	91.134	-888.933	4444.804	-4364.571	87.557	-886.787	4454.609	-4586.759	92.532	-870.775	4669.601
1280.000	-4661.211	98.182	-910.347	4750.291	-4670.733	92.828	-907.397	4758.963	-4895.400	100.285	-893.088	4977.209
1320.000	-4973.699	105.659	-931.125	5061.209	-4981.026	98.172	-926.848	5067.475	-5208.627	106.515	-913.039	5289.119
1360.000	-5290.234	113.278	-951.096	5376.243	-5294.518	104.186	-945.899	5379.359	-5505.953	112.561	-933.374	5585.640
1400.000	-5608.608	120.760	-970.211	5693.187	-5610.002	110.964	-964.723	5693.428	-5801.739	118.674	-953.220	5880.721
1440.000	-5928.653	127.932	-988.555	6011.866	-5927.612	117.997	-983.240	6009.764	-6097.525	124.767	-972.448	6175.843
1480.000	-6250.302	134.711	-1006.249	6332.217	-6247.290	124.870	-1001.548	6328.295	-6393.417	130.843	-991.067	6471.098
1520.000	-6572.427	141.124	-1023.412	6653.126	-6567.355	131.572	-1020.085	6647.409	-6705.925	136.856	-1008.501	6782.716
1560.000	-6894.534	147.484	-1040.154	6974.114	-6887.661	138.500	-1039.864	6967.092	-7040.732	142.327	-1024.816	7116.348
1600.000	-7218.122	153.493	-1056.371	7296.627	-7211.456	145.041	-1059.857	7290.366	-7376.429	148.162	-1040.559	7450.934

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT ANGULAR ACCELERATIONS (REV/ SEC**2) IN LOCAL REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	.021	.053	-.001	.057	0.000	0.000	0.000	0.000
240.000	-.070	-37.372	-.844	37.382	0.000	-10.902	0.000	10.902
280.000	.467	-19.195	-1.068	19.230	0.000	-9.917	0.000	9.917
320.000	.834	9.040	-.806	9.115	.001	-54.859	.304	54.860
360.000	.421	31.673	-.343	31.678	-.075	846.123	6.572	846.149
400.000	-.458	35.215	-1.439	35.247	-.043	-711.759	14.780	711.912
440.000	.156	78.135	-8.999	78.652	.053	-431.976	4.615	432.001
480.000	-13.205	55.985	4.131	57.670	-.019	747.441	12.949	747.553
520.000	5.887	-82.929	23.756	86.465	.009	-380.697	-.354	380.697
560.000	7.351	-68.655	-8.831	69.610	-.008	133.970	-2.745	133.998
600.000	6.711	-43.819	-12.168	45.970	-.028	-44.107	-.507	44.109
640.000	2.203	-29.330	5.417	29.908	-.007	-3.942	-2.331	4.580
680.000	-2.552	9.331	8.863	13.120	.001	-1.504	-2.753	3.137
720.000	-.481	52.097	-5.008	52.339	-.013	.082	-.638	.644
760.000	4.033	41.524	-13.620	43.886	-.008	3.528	1.684	3.909
800.000	-2.026	28.962	-10.073	30.731	-.000	1.712	-.103	1.715
840.000	-8.549	-1.238	7.574	11.488	-.000	1.785	-.104	1.788
880.000	-3.859	-20.100	19.886	28.537	.002	2.300	-.059	2.301
920.000	-.007	-22.914	7.442	24.092	.001	.391	.765	.859
960.000	3.716	-22.050	-9.070	24.130	-.006	-1.358	1.396	1.947
1000.000	4.765	-17.849	-13.167	22.686	-.006	-1.743	.931	1.981
1040.000	4.009	-11.341	-4.356	12.793	.001	-1.130	-.266	1.161
1080.000	1.012	-2.072	7.706	8.044	.003	-.589	-1.827	1.919
1120.000	-2.071	10.369	9.305	14.085	-.002	-.269	-1.773	1.793
1160.000	-1.900	16.935	2.662	17.248	-.005	.063	-.563	.567
1200.000	.629	18.190	-3.956	18.624	-.005	.306	.464	.556
1240.000	2.074	15.783	-8.300	17.953	-.003	.202	.829	.854
1280.000	.392	10.882	-8.783	13.990	-.001	-.117	.519	.532
1320.000	-2.727	2.602	-3.335	5.033	-.003	6.119	3.105	6.862
1360.000	-1.693	-6.093	-2.713	6.882	.002	0.000	.000	.002
1400.000	1.121	-5.621	-4.503	7.289	.002	0.000	.000	.002
1440.000	2.992	-3.865	-5.011	7.000	.002	0.000	.000	.002
1480.000	6.170	.640	-14.973	16.207	.097	60.141	-64.650	88.298
1520.000	3.172	3.790	-30.460	30.853	.595	-18.851	-70.828	73.296
1560.000	-4.787	-5.301	-1.995	7.416	-.137	0.000	-.004	.137
1600.000	-4.964	-8.183	-2.856	9.983	-.268	0.000	.002	.268

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT ANGULAR VELOCITIES (REV/ SEC) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - [illegible]				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	.000	.000	-.000	.000	0.000	0.000	0.000	0.000
240.000	-.005	-.998	.022	.998	0.000	-.152	0.000	.152
280.000	.010	-2.178	-.009	2.178	0.000	-.687	0.000	.687
320.000	.057	-2.362	-.027	2.363	-.000	.211	-.004	.211
360.000	.083	-1.521	-.001	1.523	-.011	-2.103	-.027	2.103
400.000	.114	-.102	.046	.160	.003	1.795	.019	1.795
440.000	.285	1.754	.162	1.784	-.010	1.535	-.026	1.535
480.000	.372	5.386	.413	5.414	.010	-1.852	-.010	1.852
520.000	.276	4.140	.973	4.262	.001	.348	-.021	.349
560.000	.452	.893	.364	1.064	.004	.567	.012	.567
600.000	.017	-1.080	-.471	1.178	.008	.350	.065	.356
640.000	-.123	-2.580	-1.087	2.803	.012	.074	.077	[illegible]
680.000	-.001	-3.145	-.873	3.264	.003	-.071	.010	[illegible]
720.000	-.023	-1.819	-.306	1.844	-.004	-.210	-.049	.216
760.000	.273	.186	.227	.401	-.004	-.166	-.037	.170
800.000	.569	1.695	.543	1.869	-.002	-.070	-.065	.071
840.000	.383	2.258	.757	2.412	-.003	-.010	-.012	.016
880.000	.242	1.460	1.004	1.788	-.004	.083	-.019	.085
920.000	.422	.417	.898	1.076	-.003	.139	-.003	.140
960.000	.350	-.256	.288	.521	.003	.118	.043	.126
1000.000	.039	-.567	-.581	.812	.011	.059	.086	.101
1040.000	-.109	-.735	-1.270	1.471	.015	-.009	.100	.101
1080.000	-.019	-.975	-1.431	1.731	.010	-.043	.054	.069
1120.000	-.005	-1.123	-1.050	1.537	-.001	-.059	-.022	.063
1160.000	-.081	-.892	-.477	1.015	-.009	-.062	-.070	.094
1200.000	-.029	-.404	.053	.408	-.009	.054	-.072	.090
1240.000	.170	.163	.430	.535	-.007	-.043	-.046	.064
1280.000	.374	.719	.755	1.108	-.004	-.042	-.018	.046
1320.000	.403	1.099	.869	1.458	-.005	-.070	-.032	.077
1360.000	.272	1.103	.708	1.338	.000	-.074	.025	.078
1400.000	.143	1.128	.456	1.225	.000	-.074	.025	.078
1440.000	.025	1.240	.215	1.259	.000	-.074	.025	.078
1480.000	-.098	1.452	.030	1.455	-.018	.252	-.306	.397
1520.000	-.547	2.717	.042	2.772	-.022	.728	-.651	.977
1560.000	-.671	2.989	.297	3.078	-.014	-.268	-.410	.490
1600.000	-.577	2.951	.608	3.067	.048	.398	.532	.666

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT ANGULAR DISPLACEMENTS (DEG) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	YAW	PITCH	ROLL	RES	YAW	PITCH	ROLL	RES
0.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
40.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
80.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
120.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
160.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
200.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
240.000	.325	7.601	-.078	7.609	0.000	12.001	0.000	12.001
280.000	.434	-16.277	-.260	16.284	0.000	5.939	0.000	5.939
320.000	-.160	-50.308	.172	50.308	-.099	16.015	-.016	16.015
360.000	-6.238	-79.270	6.382	79.342	-.017	18.557	.007	18.557
400.000	67.460	-92.722	-66.796	91.087	.035	19.278	.003	19.278
440.000	-30.150	-80.006	31.771	81.570	.189	9.735	.031	9.737
480.000	-8.472	-27.912	12.294	30.766	.302	.441	.051	.537
520.000	2.899	47.519	10.272	48.381	-.065	-1.358	.064	1.361
560.000	62.478	76.508	62.297	84.417	-.294	2.951	.072	2.967
600.000	59.128	72.040	59.605	82.006	.293	8.794	.141	8.800
640.000	14.429	50.368	23.386	54.258	1.407	11.438	.329	11.525
680.000	-3.809	7.816	18.763	20.897	2.099	11.707	.452	11.894
720.000	-13.756	-29.607	24.348	38.281	1.678	9.500	.357	9.648
760.000	-17.437	-40.151	29.898	48.881	.953	6.585	.229	6.656
800.000	-13.435	-24.835	32.912	40.794	.690	4.955	.172	5.005
840.000	-4.551	6.159	35.471	36.500	.595	4.362	.134	4.404
880.000	10.251	33.829	40.657	50.998	.354	4.865	.084	4.878
920.000	32.124	44.444	52.178	64.664	.141	6.559	.034	6.560
960.000	45.853	41.202	58.910	70.214	.414	8.498	.042	8.509
1000.000	41.960	34.758	55.862	66.272	1.390	9.72		
1000.000	41.960	34.758	55.862	66.272	1.390	9.728	.166	9.826
1040.000	24.610	27.396	48.906	55.501	2.815	9.985	.376	10.371
1080.000	2.783	15.872	44.838	47.139	4.015	9.573	.546	10.376
1120.000	-15.452	.564	45.794	49.218	4.237	8.827	.548	9.786
1160.000	-27.039	-13.570	51.741	56.528	3.498	7.949	.406	8.682
1200.000	-31.243	-22.340	55.751	61.462	2.405	7.112	.225	7.506
1240.000	-27.990	-23.414	57.613	62.214	1.570	6.423	.080	6.600
1280.000	-19.314	-15.909	58.866	60.976	1.063	5.828	-.011	5.924
1320.000	-7.819	-1.450	61.494	61.858	.842	5.110	-.075	5.179
1360.000	4.429	14.706	65.961	66.970	1.070	4.221	-.100	4.356
1400.000	15.207	29.913	72.124	74.835	1.431	3.161	-.118	3.473
1440.000	25.524	45.403	81.104	84.698	1.792	2.101	-.142	2.767
1480.000	41.090	61.690	98.143	96.999	1.791	1.406	-.179	2.286
1520.000	-64.170	105.715	-3.154	116.928	1.638	1.162	-.215	2.021
1560.000	-6.432	139.304	58.336	147.776	-5.716	.030	-.228	5.721
1600.000	4.244	-178.175	69.019	179.099	-4.169	1.459	-.062	4.416

1 DATE: 19-MAY-82

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 1)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(95%)-SEAT

SPRING DAMPER FORCES

	SPRING DAMPER NO. 1 SEG 1(MS) - SEG 2(CH)		SPRING DAMPER NO. 2 SEG 1(MS) - SEG 2(CH)	
TIME (MSEC)	LENGTH (IN)	FORCE (LB)	LENGTH (IN)	FORCE (LB)
0.000	10.125	0.00	10.269	0.00
40.000	10.125	0.00	10.269	0.00
80.000	10.125	0.00	10.269	0.00
120.000	10.125	0.00	10.269	0.00
160.000	10.125	0.00	10.269	0.00
200.000	10.125	0.00	10.269	0.00
240.000	11.410	0.00	11.600	0.00
280.000	37.136	0.00	37.156	0.00
320.000	28.202	0.00	28.152	0.00
360.000	52.892	1547.08	53.005	1560.63
400.000	57.627	2115.30	57.863	2143.62
440.000	78.257	4590.80	78.616	4633.94
480.000	90.395	6047.38	89.828	5979.41
520.000	93.382	6405.84	92.331	6279.76
560.000	79.831	4779.71	80.256	4830.74
600.000	73.854	4062.48	74.485	4138.18
640.000	72.586	3910.36	72.127	3855.29
680.000	71.430	3771.60	70.542	3665.10
720.000	67.901	3348.06	68.052	3366.22
760.000	62.432	2691.86	63.306	2796.74
800.000	60.736	2488.36	61.403	2568.32
840.000	60.741	2488.94	59.625	2354.97
880.000	60.252	2430.22	58.109	2173.12
920.000	57.546	2105.55	56.659	1999.04
960.000	55.504	1860.42	56.372	1964.61
1000.000	53.851	1662.09	55.328	1839.35
1040.000	53.645	1637.45	54.108	1692.91
1080.000	54.188	1702.54	53.076	1569.16
1120.000	53.154	1578.48	51.689	1402.66
1160.000	51.657	1398.79	51.065	1327.78
1200.000	50.131	1215.71	50.635	1276.17
1240.000	48.827	1059.28	50.135	1216.17
1280.000	48.244	989.24	49.635	1156.22
1320.000	47.360	885.58	47.714	925.69
1360.000	28.337	0.00	27.217	0.00
1400.000	8.101	0.00	9.059	0.00
1440.000	14.034	0.00	22.177	0.00
1480.000	35.084	0.00	44.577	549.28
1520.000	37.573	0.00	48.443	1013.21
1560.000	33.291	0.00	32.463	0.00
1600.000	29.495	0.00	20.793	0.00

1 ELAPSED CPU TIME =   13.87 SECONDS

SUB	CALLS	TIME	%
MAIN3D	1	6	.43
INPUT	1	11	.79
CHAIN	2084	17	1.23
DINT	41	207	14.92
PDAUX	2500	238	17.16
DAUX	2083	215	15.50
SETUP1	2083	13	.94
CONTCT	2083	64	4.61
	2083	128	9.23
WINDY	4166	127	9.16
SFDAMP	2083	72	5.19
VISPR	2083	14	1.01
EJOINT	2083	9	.65
SETUP2	2083	13	.94
DAUX11	2083	13	.94
DAUX12	2083	11	.79
DAUX22	2083	12	.87
FSMSOL	2083	21	1.51
OUTPUT	426	71	5.12
UPDATE	425	0	0.00
DZP	2082	79	5.70
POSTPR	1	46	3.32
0TOTAL		1387	100.00

*EOR

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1  CSA   NOS/BE L530H        L530H-CMR1 03/15/82
 18.12.03.GB19LMB  FROM    /9L
 18.12.03.IP  00000128 WORDS - FILE INPUT   , DC 04
 18.12.03.GB1,T30,IO30,CM327000,STCSA.     L800764/
 18.12.03.BUTLER
 18.12.04.ACCOUNT TO BE CLOSED AT END OF MONTH
 18.12.04.CALL YOUR OCR
 18.12.04. INTERCOM BATCH JOB - NO DECK
 18.12.04.ATTACH,ATBM,ATBGBAIRFLOWBINARY1982,MR=1.
 18.12.05.AT CY= 001 SN=AFIT
 18.12.05.ATTACH,BPLT,CCPLOT56X,SN=ASD,ID=LIBRARY.
 18.12.05.AT CY= 999 SN=ASD
 18.12.05.ATTACH,AIRFLOW,ATBGBAIRFLOW95THINPUT,CY=
 18.12.05.12.
 18.12.05.ATTACH,TAPE10,SMAERO,ID=FDLTR7457,SN=AFF
 18.12.05.DL,MR=1.
 18.12.06.AT CY= 999 SN=AFFDL
 18.12.06.MAP,ON.
 18.12.06.LIBRARY,BPLT.
 18.12.06.LDSET,PRESET=ZERO.
 18.12.06.ATBM,AIRFLOW,FL=120000.
 18.15.20.    STOP  1
 18.15.20.    275600 MAXIMUM EXECUTION FL.
 18.15.20.    13.888 CP SECONDS EXECUTION TIME.
 18.15.20.OP  00018304 WORDS - FILE OUTPUT  , DC 40
 18.15.20.MS   21888  WORDS  (   69312 MAX USED)
 18.15.20.CPA      15.532 SEC.        12.657 ADJ.
 18.15.20.IO       11.702 SEC.         3.463 ADJ.
 18.15.20.CM    2292.969 KWS.         10.801 ADJ.
 18.15.20.CRUS                        26.922
 18.15.20.COST                 $       1.77
 18.15.20.PP        7.742 SEC.     DATE 05/27/82
 18.15.20.EJ  END OF JOB, 9L  L800764.
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1 AFAMRL ARTICULATED TOTAL BODY (ATB-II) MODEL

DEVELOPED BY CALSPAN CORP., P.O. BOX 400, BUFFALO NY 14225
AND BY J & J TECHNOLOGIES INC., ORCHARD PARK NY 14127

FOR THE AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY,
AFSC AERONAUTICAL SYSTEMS DIVISION, WRIGHT-PATTERSON AFB
UNDER CONTRACTS F33615-75C-5002, -78C-0516 AND -80C-0511

AND FOR THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION,
U.S. DEPARTMENT OF TRANSPORTATION, UNDER CONTRACTS
FH-11-7592, HS-053-2-485, HS-6-01300 AND HS-6-01410.

PROGRAM DOCUMENTATION: NHTSA REPORT NOS. DOT-HS-801-507
THROUGH 510 (FORMERLY CALSPAN REPORT NO. ZQ-5180-L-1),
AVAILABLE FROM NTIS (ACCESSION NOS. PB-241692,3,4 AND 5),
APPENDIXES A-J TO THE ABOVE (AVAILABLE FROM CALSPAN),
AND REPORT NOS. AMRL-TR-75-14 AND AFAMRL-TR-80-14.

PROGRAM ATB-II, EXECUTED ON THE CDC CYBER COMPUTER SYSTEM,
AFSC ASD COMPUTER CENTER, WRIGHT-PATTERSON AFB, OHIO 45433

19-MAY-82 IRSIN= 0 IRSOUT= 0 RSTIME = 0.0000 CARDS A

95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

UNITL = IN UNITM = LB UNITT = SEC GRAVITY VECTOR = (0.0000, 0.0000, 386.0880)

NDINT = 6 NSTEPS = 40 DT = .040000 H0 = .000125 HMAX = .004000 HMIN = .000125

0 NPRT ARRAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

1 CRASH VICTIM SINGLE MAN(95%)-SEAT 2 SEGMENTS 1 JOINTS CARD B.1

CARDS B.2

SEGMENT			WEIGHT	PRINCIPAL MOMENTS OF INERTIA (LB - SEC**2- IN)			SEGMENT CONTACT ELLIPSOID SEMIAXES (IN)			CENTER (IN)			PRINCIPAL AXES (DEG)		
I	SYM	PLOT	(LB)	X	Y	Z	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL
1	MS	M	369.870	238.6300	223.8000	71.6800	144.000	6.940	35.680	-6.130	0.000	9.510	0.00	-19.41	0.00
2	CH	C	25.000	25.0000	20.0000	25.0000	38.400	38.400	38.400	0.000	0.000	0.000	0.00	0.00	0.00

CARDS B.3

JOINT					LOCATION(IN) - SEG(JNT)			LOCATION(IN) - SEG(J+1)			PRIN. AXIS(DEG) - SEG(JNT)			PRIN. AXIS(DEG) - SEG(J+1)		
J	SYM	PLOT	JNT	PIN	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL	YAW	PITCH	ROLL
1	NULL	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	.00

1 JOINT TORQUE CHARACTERISTICS

CARDS B.4

JOINT	FLEXURAL SPRING CHARACTERISTICS: SPRING COEF. (IN LB /DEG**J) LINEAR (J=1)	QUADRATIC (J=2)	CUBIC (J=3)	ENERGY DISSIPATION COEF.	JOINT STOP (DEG)	TORSIONAL SPRING CHARACTERISTICS: SPRING COEF. (IN LB /DEG**J) LINEAR (J=1)	QUADRATIC (J=2)	CUBIC (J=3)	ENERGY DISSIPATION COEF.	JOINT STOP (DEG)
1 NULL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CARDS B.5

JOINT VISCOUS CHARACTERISTICS AND LOCK-UNLOCK CONDITIONS

JOINT	VISCOUS COEFFICIENT (IN LB SEC/DEG)	COULOMB FRICTION COEF. (IN LB)	FULL FRICTION ANGULAR VELOCITY (DEG/ SEC)	MAX TORQUE FOR A LOCKED JOINT (IN LB)	MIN TORQUE FOR UNLOCKED JOINT (IN LB)	MIN. ANG. VELOCITY FOR UNLOCKED JOINT (RAD/ SEC)	IMPULSE RESTITUTION COEFFICIENT
1 NULL	0.000	0.00	0.00	0.00	0.00	0.00	0.000

SEGMENT INTEGRATION CONVERGENCE TEST INPUT

SEGMENT		ANGULAR VELOCITIES (RAD/ SEC)			LINEAR VELOCITIES (IN / SEC)			ANGULAR ACCELERATIONS (RAD/ SEC**2)			LINEAR ACCELERATIONS (IN / SEC**2)		
NO.	SYM	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR
1	MS	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000
2	CH	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000

1 VEHICLE DECELERATION INPUTS CARDS C

AIRFRAME

YAW	PITCH	ROLL	VIPS	VTIME	X0(X)	X0(Y)	X0(Z)	NATAB	AT0	ADT	MSEG
0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0	0.000000	0.000000	0

0 PASSENGER COMPARTMENT DISPLACEMENT HISTORY
ANALYTICAL HALF-SINE WAVE DECELERATION
V0= 0.000 IN / SEC, OBLIQUE ANGLES = 0.00 0.00 0.00 DEGREES, TIME DURATION = 1.000 SEC

1 NPL NBLT NBAG NELP NQ NSD NHRNSS NWINDF NJNTF NFORCE CARD D.1

NPL	NBLT	NBAG	NELP	NQ	NSD	NHRNSS	NWINDF	NJNTF	NFORCE
1	0	0	0	0	2	0	1	0	4

0 PLANE INPUTS CARDS D.2

0 PLANE NO. 1 EJEC PLANE

	X	Y	Z
POINT 1	30.0000	30.0000	-100.0000
POINT 2	-30.0000	30.0000	-100.0000
POINT 3	-30.0000	-30.0000	-100.0000

0 BODY SEGMENT SYMMETRY INPUT CARD D.7

SEG NO.	1	2
0 NSYM(J)	0	0

0 SPRING DAMPERS FUNCTION INPUT CARDS D.8

COORDINATES OF ATTACHMENT POINTS (IN)

SEGMENT			SEGMENT M			SEGMENT N			SPRING FORCE FUNCTION			DAMPING FORCE FUNCTION	
NO.	M	N	X	Y	Z	X	Y	Z	D0	A1	A2	B1	B2
1	1	2	-12.73	6.12	-2.97	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000
2	1	2	-12.73	-6.12	-2.97	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000

0 FORCE FUNCTIONS INPUT CARDS D.9

NO.	SEG	FCN1	FCN2	X	Y	Z	YAW	PITCH	ROLL
1	1	1	0	-10.558	0.000	9.858	0.000	40.750	0.000
2	1	-2	3	-3.620	0.000	17.910	0.000	77.600	0.000
3	1	4	0	-11.530	0.000	-6.630	0.000	-30.000	0.000
4	2	5	0	0.000	0.000	0.000	0.000	150.000	0.000

1FUNCTION NO. 1 SUSTAINER ROCKET NTI(1) = 1 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 9 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.214000	3425.0000
.243000	3680.0000
.354000	3400.0000
.494000	3150.0000
.605000	1000.0000
.653000	0.0000
1.600000	0.0000

0FUNCTION NO. 2 STAPAC ROCKET NTI(2) = 25 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 12 TABULAR POINTS

D	F(D)
0.000000	0.0000
.198000	0.0000
.199000	23.4000
.203000	890.6000
.204000	703.1000
.428000	723.8000
.698000	492.2000
.742000	515.6000
.755000	445.3000
.779000	82.0000
.800000	0.0000
1.600000	0.0000

1FUNCTION NO. 3 STAPAC PITCH VS RATE NTI(3) = 55 CARDS E

D0	D1	D2	D3	D4
-6.2830	-6.2830	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 4 TABULAR POINTS

D	F(D)
-6.283000	-.7854
-1.571000	-.7854
1.571000	.7854
6.283000	.7854

0FUNCTION NO. 4 DROGUE GUN ON SEAT NTI(4) = 69 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	1756.0000
.216000	1756.0000
.217000	0.0000
1.600000	0.0000

1FUNCTION NO. 5 DROGUE GUN ON CHUTE NTI(5) = 87 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	2200.0000
.216000	2200.0000
.217000	0.0000
1.600000	0.0000

0FUNCTION NO. 6 CHUTE CA FUNCTION NTI(6) = 105 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 8 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.355000	.0300
.478000	.4600
.500000	.4600
1.300000	.4600
1.316000	0.0000
1.600000	0.0000

1 WIND FORCE FUNCTION NO. 41 WIND FORCE ON CHUTE NTI(41) = 127

D0	D1	D2	D3	D4
0.0000	0.0000	0.0000	0.0000	0.0000

0 WIND FORCE TABLES FOR 2 TIME POINTS.

T	FX(T)	FY(T)	FZ(T)
0.000000	0.	0.	0.
.001000	-10.0000	0.	0.

1 ALLOWED CONTACTS AND ASSOCIATED FUNCTIONS

SEGMENT-ELLIPSOID	SEGMENT-PLANE	WIND FORCE FUNCTION
0 2 - -2	3 - 1	6
CH	VEH - EJEC PLANE	CHUTE CA FUNCTION

1 SUBROUTINE INITAL INPUT CARD G.1

ZPLT(X)	ZPLT(Y)	ZPLT(Z)	I1	J1	I2	J2	I3	SPLT(1)	SPLT(2)	SPLT(3)
1.	1.	1.	0	0	0	0	1	10.00	6.00	1.00

0 INITIAL POSITIONS (INERTIAL REFERENCE) CARDS G.2

SEGMENT		LINEAR POSITION (IN)			LINEAR VELOCITY (IN / SEC)		
NO.	SEG	X	Y	Z	X	Y	Z
1	MS	3.92635	0.00000	-10.61135	-98.71270	0.00000	-527.50090
2	CH	-178.01766	0.00000	34.84606	-98.71270	0.00000	-527.50090

0 INITIAL ANGULAR ROTATION AND VELOCITY CARDS G.3

SEGMENT		ANGULAR ROTATION (DEG)			ANGULAR VELOCITY (DEG/ SEC)			IYPR			
NO.	SEG	YAW	PITCH	ROLL	X	Y	Z				
1	MS										
1	MS	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0
2	CH	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0

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1    TIME        MACH     ALPHA     BETA          CX          CY        CZ            CL        CM         CN


 CA' .1  3      1  1  2
 CARD H.2  3    1  1  2
 CARD H.3  3    1  1  2
 CARD H.4  2    1  2
 CARD H.5  2    1  2
 CARD H.6  2    1  2
 CARD H.7  0    0
   214.00       .9019    10.36     0.00      -8288.94      0.00    1997.39          0.00 -60960.41      0.00
   240.00       .8845     5.11     0.00      -8339.72      0.00    2542.93          0.00 -64019.63      0.00
   280.00       .8647   -19.74     0.00      -8117.89      0.00    3226.46          0.00 -38286.12      0.00
0 DINT CONV. TEST   288.000   CH    ANG ACC   4977.       8796.      .2207       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .288000 FOR H =   .004000
   320.00       .8589   -54.90     0.00      -6121.52      0.00    4391.90          0.00   1329.76      0.00
   360.00       .8599   -83.95     0.00      -2443.99      0.00    3870.70          0.00   -240.66      0.00
   400.00       .8467   -94.56     0.00       -342.99      0.00    3031.25          0.00  -4251.88      0.00
0 DINT CONV. TEST   420.000   CH    ANG ACC   .8128E+06   .3092E+06   .1255E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .420000 FOR H =   .004000
   440.00       .8260   -83.74     0.00      -2264.41      0.00    3533.93          0.00    535.29      0.00
0 DINT CONV. TEST   468.000   CH    ANG ACC   .3859E+07   .7650E+07   1.955       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .468000 FOR H =   .004000
0 DINT CONV. TEST   472.000   CH    ANG ACC   .1490E+08   .1463E+07   .9457E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .472000 FOR H =   .004000
   480.00       .8092   -30.74     0.00      -7015.86      0.00    3298.96          0.00 -22226.82      0.00
0 DINT CONV. TEST   480.000   CH    ANG ACC   .3177E+08   .3182E+07   .1001       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .480000 FOR H =   .004000
0 DINT CONV. TEST   484.000   CH    ANG ACC   3727.       .2057E+06   5.749       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .484000 FOR H =   .004000
0 DINT CONV. TEST   496.000   CH    ANG ACC   .4193E+06   .6486E+06   .1586       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .496000 FOR H =   .004000
0 DINT CONV. TEST   500.000   CH    ANG ACC   .8865E+07   .4394E+06   .4840E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .500000 FOR H =   .004000
0 DINT CONV. TEST   508.000   CH    ANG ACC   .6821E+07   .1789E+06   .2469E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .508000 FOR H =   .004000
0 DINT CONV. TEST   512.000   CH    ANG ACC   .9693E+05   .2362E+05   .2066       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .512000 FOR H =   .004000
   520.00       .7561    42.26     0.00      -3028.63      0.00   -2384.42          0.00 -11439.36      0.00
0 DINT CONV. TEST   524.000   CH    ANG ACC   .6196E+07   .5898E+06   .9346E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .524000 FOR H =   .004000
0 DINT CONV. TEST   528.000   CH    ANG ACC   .1865E+06   6315.       .3147E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .528000 FOR H =   .004000
0 DINT CONV. TEST   540.000   CH    ANG ACC   .7309E+06   .1353E+06   .1765       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .540000 FOR H =   .004000
0 DINT CONV. TEST   556.000   CH    ANG ACC   .2784E+06   .2214E+05   .7624E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .556000 FOR H =   .004000
   560.00       .6895    77.76     0.00        -94.53      0.00   -3281.61          0.00  25693.87      0.00
0 DINT CONV. TEST   568.000   CH    ANG ACC   .5724E+05   .1243E+05   .2116       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .568000 FOR H =   .004000
   600.00       .6459    74.65     0.00       -564.39      0.00   -2746.07          0.00  20236.29      0.00
0 DINT CONV. TEST   620.000   CH    ANG ACC   2734.       1897.       .6679       .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .620000 FOR H =   .004000
   640.00       .6048    45.26     0.00      -1069.68      0.00   -1541.97          0.00  -4141.75      0.00
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680.00	.5710	-.81	0.00	-3092.93	0.00	1167.08	0.00	-24746.95	0.00
720.00	.5520	-39.26	0.00	-2496.22	0.00	1370.32	0.00	-4571.67	0.00
760.00	.5341	-49.21	0.00	-2093.33	0.00	1355.61	0.00	-374.21	0.00
800.00	.5167	-34.19	0.00	-2289.57	0.00	1168.87	0.00	-6302.88	0.00
840.00	.4994	-4.26	0.00	-2222.08	0.00	799.26	0.00	-17244.61	0.00
880.00	.4762	25.70	0.00	-1365.59	0.00	-217.48	0.00	-10672.90	0.00
920.00	.4537	45.82	0.00	-580.07	0.00	-878.26	0.00	-2188.40	0.00
960.00	.4345	53.09	0.00	-343.63	0.00	-928.73	0.00	422.69	0.00
1000.00	.4170	47.86	0.00	-432.08	0.00	-778.26	0.00	-1363.83	0.00
1040.00	.4002	31.98	0.00	-778.39	0.00	-346.89	0.00	-5640.72	0.00
1080.00	.3845	9.02	0.00	-1277.97	0.00	314.99	0.00	-10144.56	0.00
1120.00	.3720	-15.57	0.00	-1214.50	0.00	508.96	0.00	-7250.55	0.00
1160.00	.3627	-34.64	0.00	-1125.98	0.00	578.28	0.00	-3005.11	0.00
1200.00	.3541	-43.79	0.00	-973.88	0.00	584.68	0.00	-1058.16	0.00
1240.00	.3456	-42.28	0.00	-945.39	0.00	550.07	0.00	-1260.28	0.00
1280.00	.3380	-31.59	0.00	-991.09	0.00	489.42	0.00	-3197.98	0.00
1320.00	.3306	-14.69	0.00	-958.35	0.00	398.72	0.00	-5874.87	0.00
1360.00	.3259	3.38	0.00	-988.21	0.00	329.70	0.00	-7943.00	0.00
1400.00	.3220	18.73	0.00	-746.80	0.00	40.40	0.00	-5789.17	0.00
1440.00	.3190	31.77	0.00	-498.66	0.00	-216.63	0.00	-3622.10	0.00
1480.00	.3168	43.29	0.00	-323.97	0.00	-391.91	0.00	-1492.59	0.00
1520.00	.3214	56.79	0.00	-154.90	0.00	-526.44	0.00	983.56	0.00
1560.00	.3187	73.96	0.00	-12.47	0.00	-552.15	0.00	3242.58	0.00
1600.00	.3152	92.51	0.00	166.73	0.00	-585.08	0.00	5098.47	0.00

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCK
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT LINEAR ACCELERATIONS (G'S) IN LOCAL REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-6.13, 0.00, 9.51) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
40.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
80.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
120.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
160.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
200.000	-.077	0.000	.342	.351	-.071	0.000	.350	.357	-.216	0.000	.976	1.000
240.000	-14.591	0.000	-7.495	16.403	-17.903	0.000	-13.648	22.511	-8.605	0.000	-.449	8.616
280.000	-14.355	0.000	-5.471	15.363	-12.175	0.000	-11.617	16.828	-20.402	0.000	-.303	20.405
320.000	-10.021	0.000	-.854	10.057	-3.902	0.000	-3.490	5.236	-29.738	0.000	-6.215	30.381
360.000	2.836	0.000	8.646	9.100	8.527	0.000	11.632	14.423	59.627	0.000	-43.730	73.944
400.000	8.535	0.000	10.788	13.756	12.521	0.000	15.912	20.247	-67.073	0.000	-41.341	78.791
440.000	-2.696	0.000	24.650	24.797	9.073	0.000	33.891	35.085	1.884	0.000	8.132	8.347
480.000	-42.947	0.000	12.074	44.612	-9.874	0.000	-.598	9.892	-24.718	0.000	42.735	49.369
520.000	-23.371	0.000	-40.983	47.179	-16.637	0.000	-66.125	68.185	4.688	0.000	45.047	45.291
560.000	.136	0.000	-38.503	38.503	-6.804	0.000	-49.011	49.481	-68.209	0.000	-21.358	71.474
600.000	-3.619	0.000	-31.032	31.242	-7.340	0.000	-38.433	39.127	-37.814	0.000	-36.760	52.737
640.000	-16.679	0.000	-18.669	25.034	-12.881	0.000	-28.364	31.152	-19.995	0.000	-30.338	36.335
680.000	-27.838	0.000	2.596	27.959	-17.227	0.000	-3.322	17.544	-11.988	0.000	-14.801	19.047
720.000	-19.526	0.000	13.311	23.631	-10.730	0.000	18.625	21.495	-23.535	0.000	3.836	23.846
760.000	-16.254	0.000	12.532	20.524	-11.557	0.000	18.466	21.785	-35.264	0.000	13.778	37.860
800.000	-18.039	0.000	9.043	20.179	-12.068	0.000	11.126	16.414	-21.331	0.000	12.434	24.690
840.000	-19.431	0.000	1.302	19.474	-14.707	0.000	-2.649	14.944	-13.799	0.000	8.055	15.978
880.000	-14.767	0.000	-6.957	16.324	-13.859	0.000	-12.127	18.416	-10.625	0.000	3.035	11.050
920.000	-9.132	0.000	-10.469	13.892	-10.938	0.000	-14.515	18.175	-15.983	0.000	-2.489	16.176
960.000	-7.161	0.000	-10.286	12.533	-9.633	0.000	-13.477	16.566	-16.208	0.000	-6.348	17.406
1000.000	-7.970	0.000	-8.581	11.711	-9.487	0.000	-11.690	15.055	-13.146	0.000	-7.579	15.174
1040.000	-10.291	0.000	-5.076	11.475	-9.868	0.000	-8.212	12.838	-10.473	0.000	-6.922	12.554
1080.000	-12.559	0.000	-.157	12.560	-10.233	0.000	-2.652	10.571	-7.511	0.000	-5.002	9.025
1120.000	-11.182	0.000	3.809	11.813	-7.864	0.000	3.440	8.529	-9.524	0.000	-1.925	9.717
1160.000	-8.932	0.000	5.737	10.616	-6.037	0.000	7.504	9.631	-12.391	0.000	1.491	12.480
1200.000	-7.260	0.000	6.091	9.477	-5.079	0.000	8.749	10.116	-13.026	0.000	3.825	13.576
1240.000	-6.979	0.000	5.490	8.879	-4.948	0.000	7.766	9.208	-11.734	0.000	4.581	12.596
1280.000	-7.579	0.000	4.198	8.664	-5.377	0.000	5.165	7.456	-9.976	0.000	4.281	10.856
1320.000	-7.426	0.000	2.263	7.763	-5.477	0.000	1.517	5.683	72.211	0.000	.761	72.215
1360.000	-3.001	0.000	.936	3.143	-2.382	0.000	-.860	2.533	-.089	0.000	.996	1.000
1400.000	-2.379	0.000	.331	2.402	-1.970	0.000	-.946	2.185	-.086	0.000	.996	1.000
1440.000	-1.707	0.000	-.224	1.721	-1.351	0.000	-1.100	1.742	-.062	0.000	.997	1.000
1480.000	.049	0.000	.552	.554	.822	0.000	.411	.919	-26.234	0.000	2.437	26.347
1520.000	.069	0.000	.726	.730	1.990	0.000	.623	2.085	-29.430	0.000	.199	29.431
1560.000	-.525	0.000	-1.276	1.380	1.148	0.000	-2.036	2.338	.031	0.000	1.000	1.000
1600.000	-.032	0.000	-1.525	1.526	2.115	0.000	-2.346	3.159	.105	0.000	.994	1.000

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT LINEAR VELOCITIES (IN / SEC) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-6.13, 0.00, 9.51) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-98.713	0.000	-527.501	536.658	-98.713	0.000	-527.501	536.658	-98.713	0.000	-527.501	536.658
40.000	-98.713	0.000	-512.057	521.485	-98.713	0.000	-512.057	521.485	-98.713	0.000	-512.057	521.485
80.000	-98.713	0.000	-496.614	506.329	-98.713	0.000	-496.614	506.329	-98.713	0.000	-496.614	506.329
120.000	-98.713	0.000	-481.170	491.192	-98.713	0.000	-481.170	491.192	-98.713	0.000	-481.170	491.192
160.000	-98.713	0.000	-465.727	476.073	-98.713	0.000	-465.727	476.073	-98.713	0.000	-465.727	476.073
200.000	-98.713	0.000	-450.450	461.140	-98.711	0.000	-450.449	461.138	-98.713	0.000	-450.283	460.976
240.000	-255.834	0.000	-508.308	569.059	-306.350	0.000	-558.148	636.694	-316.079	0.000	-487.487	580.990
280.000	-466.790	0.000	-620.990	776.867	-523.533	0.000	-765.069	927.048	-540.516	0.000	-462.979	711.693
320.000	-619.859	0.000	-769.180	987.858	-583.446	0.000	-933.054	1100.454	-934.011	0.000	-454.429	1038.693
360.000	-687.724	0.000	-822.941	1072.472	-616.129	0.000	-903.759	1093.798	-1014.648	0.000	-610.604	1184.208
400.000	-845.678	0.000	-700.866	1098.355	-840.195	0.000	-704.967	1096.771	-1230.632	0.000	-1333.997	1814.939
440.000	-1099.385	0.000	-611.758	1258.132	-1186.076	0.000	-520.208	1295.142	-2031.445	0.000	-1622.283	2599.725
480.000	-1620.286	0.000	-697.014	1763.847	-1557.609	0.000	-317.320	1589.603	-2036.729	0.000	-1116.105	2322.489
520.000	-2332.792	0.000	-823.036	2473.723	-2032.753	0.000	-800.319	2184.627	-2017.564	0.000	-310.674	2041.343
560.000	-3002.786	0.000	-932.120	3144.133	-2947.880	0.000	-966.043	3102.134	-2558.123	0.000	-165.402	2563.465
600.000	-3527.927	0.000	-987.048	3663.404	-3601.270	0.000	-947.276	3723.772	-3523.553	0.000	-562.390	3568.152
640.000	-3953.969	0.000	-992.595	4076.655	-4151.584	0.000	-995.326	4269.230	-3998.631	0.000	-1024.122	4127.696
680.000	-4348.407	0.000	-923.962	4445.487	-4507.881	0.000	-1068.412	4637.417	-4323.004	0.000	-1316.223	4518.939
720.000	-4745.014	0.000	-877.608	4825.490	-4758.383	0.000	-1003.957	4863.141	-4564.416	0.000	-1355.528	4761.444
760.000	-5073.315	0.000	-878.658	5148.841	-5074.745	0.000	-860.477	5147.179	-5040.218	0.000	-1133.573	5166.119
800.000	-5384.515	0.000	-893.736	5458.183	-5362.490	0.000	-773.086	5417.929	-5454.044	0.000	-879.377	5524.482
840.000	-5690.885	0.000	-879.300	5758.414	-55[illegible].718	0.000	-755.222	5634.560	-5708.303	0.000	-698.618	5750.894
880.000	-5969.949	0.000	-835.138	6028.080	-5846.469	0.000	-793.612	5900.036	-5875.549	0.000	-597.801	5905.982
920.000	-6199.275	0.000	-809.315	6251.880	-6131.528	0.000	-811.289	6184.968	-6077.130	0.000	-574.462	6104.221
960.000	-6401.172	0.000	-791.303	6449.896	-6398.738	0.000	-791.676	6447.527	-6343.699	0.000	-613.075	6373.255
1000.000	-6586.586	0.000	-769.066	6631.327	-6642.036	0.000	-765.999	6686.060	-6582.884	0.000	-687.709	6618.708
1040.000	-6761.305	0.000	-736.343	6801.283	-6858.105	0.000	-758.362	6899.907	-6784.820	0.000	-767.067	6828.043
1080.000	-6939.841	0.000	-687.854	6973.846	-7038.443	0.000	-758.446	7079.189	-6934.844	0.000	-833.389	6984.740
1120.000	-7125.291	0.000	-641.951	7154.151	-7181.669	0.000	-739.262	7219.617	-7069.803	0.000	-862.999	7122.281
1160.000	-7297.061	0.000	-616.824	7323.085	-7310.892	0.000	-688.058	7343.199	-7238.126	0.000	-835.970	7286.241
1200.000	-7450.887	0.000	-604.300	7475.352	-7451.423	0.000	-624.698	7477.563	-7429.702	0.000	-763.134	7468.792
1240.000	-7591.847	0.000	-596.253	7615.225	-7590.464	0.000	-565.954	7611.533	-7611.438	0.000	-672.458	7641.086
1280.000	-7726.732	0.000	-588.252	7749.092	-7710.678	0.000	-519.277	7728.144	-7771.759	0.000	-584.945	7793.741
1320.000	-7857.772	0.000	-573.800	7878.694	-7810.926	0.000	-492.976	7826.468	-7632.847	0.000	-544.143	7652.219
1360.000	-7918.542	0.000	-554.543	7937.936	-7856.238	0.000	-499.246	7872.085	-7372.668	0.000	-553.272	7393.398
1400.000	-7955.082	0.000	-532.421	7972.879	-7892.735	0.000	-501.748	7908.667	-7372.668	0.000	-537.928	7392.259
1440.000	-7981.459	0.000	-514.885	7998.049	-7923.240	0.000	-501.253	7939.080	-7372.668	0.000	-522.385	7391.151
1480.000	-8000.746	0.000	-504.028	8016.607	-7945.595	0.000	-502.433	7961.464	-7397.446	0.000	-503.503	7414.561
1520.000	-7950.239	0.000	-502.439	7966.100	-7868.986	0.000	-519.922	7886.143	-8437.342	0.000	-424.615	8448.019
1560.000	-7968.708	0.000	-497.166	7984.202	-7891.807	0.000	-540.745	7910.311	-8468.557	0.000	-409.168	8478.436
1600.000	-7989.966	0.000	-493.722	8005.206	-7924.814	0.000	-566.970	7945.069	-8468.557	0.000	-393.725	8477.705

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT LINEAR DISPLACEMENTS (IN) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-6.13, 0.00, 9.51) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	3.926	0.000	-10.611	11.314	-.000	0.000	-.000	.000	-178.018	0.000	34.846	181.396
40.000	-.022	0.000	-31.403	31.403	-3.949	0.000	-20.791	21.163	-181.966	0.000	14.055	182.508
80.000	-3.971	0.000	-51.576	51.729	-7.897	0.000	-40.965	41.719	-185.915	0.000	-6.119	186.015
120.000	-7.919	0.000	-71.132	71.571	-11.846	0.000	-60.520	61.669	-189.863	0.000	-25.674	191.591
160.000	-11.868	0.000	-90.070	90.848	-15.794	0.000	-79.458	81.013	-193.812	0.000	-44.612	198.880
200.000	-15.816	0.000	-108.390	109.538	-19.743	0.000	-97.778	99.752	-197.760	0.000	-62.932	207.532
240.000	-21.806	0.000	-127.232	129.087	-26.624	0.000	-116.995	119.986	-206.753	0.000	-82.082	222.451
280.000	-36.488	0.000	-149.589	153.975	-45.040	0.000	-142.180	149.143	-223.276	0.000	-101.115	245.105
320.000	-58.551	0.000	-177.417	186.829	-69.784	0.000	-176.061	189.387	-252.249	0.000	-119.818	279.259
360.000	-84.543	0.000	-209.816	226.209	-95.025	0.000	-214.078	234.220	-296.127	0.000	-139.223	327.222
400.000	-115.102	0.000	-240.626	266.739	-124.505	0.000	-246.919	276.533	-333.617	0.000	-179.038	378.622
440.000	-153.257	0.000	-266.570	307.486	-163.591	0.000	-271.177	316.701	-403.657	0.000	-238.929	469.069
480.000	-206.656	0.000	-292.038	357.761	-216.573	0.000	-286.590	359.218	-482.766	0.000	-296.683	566.642
520.000	-285.630	0.000	-322.491	430.795	-282.686	0.000	-311.566	420.695	-565.428	0.000	-324.524	651.939
560.000	-392.758	0.000	-357.949	531.400	-383.950	0.000	-350.847	520.107	-652.846	0.000	-331.141	732.026
600.000	-523.748	0.000	-396.449	656.874	-515.355	0.000	-388.861	645.603	-776.023	0.000	-344.881	849.208
640.000	-673.719	0.000	-436.151	802.574	-670.107	0.000	-425.429	793.746	-927.299	0.000	-376.945	1000.985
680.000	-839.607	0.000	-474.723	964.521	-844.650	0.000	-464.595	963.992	-1094.330	0.000	-424.430	1173.754
720.000	-1021.636	0.000	-510.524	1142.093	-1031.853	0.000	-505.662	1149.093	-1271.663	0.000	-478.898	1358.849
760.000	-1218.195	0.000	-545.513	1334.759	-1229.128	0.000	-542.601	1343.567	-1463.159	0.000	-529.198	1555.919
800.000	-1427.361	0.000	-581.029	1541.089	-1437.184	0.000	-575.413	1548.095	-1673.773	0.000	-569.264	1767.930
840.000	-1648.921	0.000	-616.627	1760.445	-1654.539	0.000	-606.806	1762.303	-1897.366	0.000	-600.560	1990.143
880.000	-1882.336	0.000	-650.899	1991.697	-1882.173	0.000	-639.586	1987.875	-2129.194	0.000	-626.220	2219.373
920.000	-2125.834	0.000	-683.731	2233.083	-2121.765	0.000	-673.174	2225.994	-2367.929	0.000	-649.425	2455.370
960.000	-2377.912	0.000	-715.747	2483.296	-2372.580	0.000	-705.768	2475.328	-2616.311	0.000	-673.006	2701.485
1000.000	-2637.713	0.000	-746.976	2741.442	-2633.370	0.000	-736.528	2734.430	-2874.985	0.000	-698.957	2958.730
1040.000	-2904.696	0.000	-777.131	3006.857	-2903.396	0.000	-765.891	3002.715	-3142.473	0.000	-728.075	3225.713
1080.000	-3178.672	0.000	-805.658	3279.183	-3181.826	0.000	-794.793	3279.590	-3417.041	0.000	-760.154	3500.572
1120.000	-3460.013	0.000	-832.184	3558.683	-3467.362	0.000	-823.581	3563.830	-3697.054	0.000	-794.256	3781.408
1160.000	-3748.514	0.000	-857.299	3845.299	-3758.273	0.000	-851.574	3853.544	-3983.094	0.000	-828.424	4068.332
1200.000	-4043.530	0.000	-881.698	4138.542	-4054.099	0.000	-877.659	4148.012	-4276.431	0.000	-860.514	4362.149
1240.000	-4344.415	0.000	-905.701	4437.819	-4354.964	0.000	-901.458	4447.226	-4577.320	0.000	-889.242	4662.897
1280.000	-4650.793	0.000	-929.401	4742.753	-4660.339	0.000	-923.319	4750.924	-4885.066	0.000	-914.357	4969.902
1320.000	-4962.515	0.000	-952.673	5053.132	-4969.862	0.000	-944.069	5058.735	-5197.419	0.000	-936.368	5281.094
1360.000	-5278.283	0.000	-975.257	5367.625	-5282.555	0.000	-964.788	5369.933	-5493.854	0.000	-958.666	5576.870
1400.000	-5595.798	0.000	-996.989	5683.919	-5597.134	0.000	-985.753	5683.276	-5788.761	0.000	-980.488	5871.210
1440.000	-5914.556	0.000	-1017.911	6001.509	-5913.328	0.000	-1006.664	5998.401	-6083.668	0.000	-1001.693	6165.582
1480.000	-6234.238	0.000	-1038.269	6320.105	-6230.788	0.000	-1027.493	6314.939	-6378.614	0.000	-1022.274	6460.013
1520.000	-6553.272	0.000	-1058.378	6638.183	-6547.351	0.000	-1048.736	6630.811	-6695.096	0.000	-1040.923	6775.532
1560.000	-6871.609	0.000	-1078.374	6955.710	-6363.677	0.000	-1070.944	6946.132	-7033.784	0.000	-1057.603	7112.851
1600.000	-7190.775	0.000	-1098.190	7274.150	-7180.302	0.000	-1093.907	7263.152	-7372.527	0.000	-1073.661	7450.295

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT ANGULAR ACCELERATIONS (REV/ SEC**2) IN LOCAL REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	0.000	.053	0.000	.053	0.000	0.000	0.000	0.000
240.000	0.000	-37.430	0.000	37.430	0.000	-10.902	0.000	10.902
280.000	0.000	-19.123	0.000	19.123	0.000	-9.917	0.000	9.917
320.000	0.000	9.043	0.000	9.043	0.000	-54.819	0.000	54.819
360.000	0.000	31.751	0.000	31.751	0.000	855.146	0.000	855.146
400.000	0.000	35.254	0.000	35.254	0.000	-719.542	0.000	719.542
440.000	0.000	78.828	0.000	78.828	0.000	-423.782	0.000	423.782
480.000	0.000	55.664	0.000	55.664	0.000	727.879	0.000	727.879
520.000	0.000	-85.501	0.000	85.501	0.000	-372.654	0.000	372.654
560.000	0.000	-68.196	0.000	68.196	0.000	142.988	0.000	142.988
600.000	0.000	-44.148	0.000	44.148	0.000	-59.508	0.000	59.508
640.000	0.000	-28.976	0.000	28.976	0.000	14.851	0.000	14.851
680.000	0.000	9.910	0.000	9.910	0.000	-6.187	0.000	6.187
720.000	0.000	52.073	0.000	52.073	0.000	-3.822	0.000	3.822
760.000	0.000	41.103	0.000	41.103	0.000	2.833	0.000	2.833
800.000	0.000	28.806	0.000	28.806	0.000	2.265	0.000	2.265
840.000	0.000	-1.237	0.000	1.237	0.000	1.933	0.000	1.933
880.000	0.000	-19.172	0.000	19.172	0.000	1.873	0.000	1.873
920.000	0.000	-23.376	0.000	23.376	0.000	.651	0.000	.651
960.000	0.000	-21.926	0.000	21.926	0.000	-.427	0.000	.427
1000.000	0.000	-18.390	0.000	18.390	0.000	-.897	0.000	.897
1040.000	0.000	-12.053	0.000	12.053	0.000	-1.113	0.000	1.113
1080.000	0.000	-2.972	0.000	2.972	0.000	-1.507	0.000	1.507
1120.000	0.000	9.652	0.000	9.652	0.000	-1.490	0.000	1.490
1160.000	0.000	17.216	0.000	17.216	0.000	-.431	0.000	.431
1200.000	0.000	18.665	0.000	18.665	0.000	.536	0.000	.536
1240.000	0.000	16.529	0.000	16.529	0.000	.745	0.000	.745
1280.000	0.000	11.474	0.000	11.474	0.000	.473	0.000	.473
1320.000	0.000	3.279	0.000	3.279	0.000	8.243	0.000	8.243
1360.000	0.000	-5.649	0.000	5.649	0.000	0.000	0.000	0.000
1400.000	0.000	-4.117	0.000	4.117	0.000	0.000	0.000	0.000
1440.000	0.000	-2.576	0.000	2.576	0.000	0.000	0.000	0.000
1480.000	0.000	1.968	0.000	1.968	0.000	-50.568	0.000	50.568
1520.000	0.000	5.946	0.000	5.946	0.000	28.068	0.000	28.068
1560.000	0.000	2.306	0.000	2.306	0.000	0.000	0.000	0.000
1600.000	0.000	3.626	0.000	3.626	0.000	0.000	0.000	0.000

1 DATE: 19-MAY-82

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT ANGULAR VELOCITIES (REV/ SEC) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	0.000	.000	0.000	.000	0.000	0.000	0.000	0.000
240.000	0.000	-.998	0.000	.998	0.000	-.152	0.000	.152
280.000	0.000	-2.178	0.000	2.178	0.000	-.687	0.000	.687
320.000	0.000	-2.361	0.000	2.361	0.000	.211	0.000	.211
360.000	0.000	-1.519	0.000	1.519	0.000	-2.078	0.000	2.078
400.000	0.000	-.096	0.000	.096	0.000	1.782	0.000	1.782
440.000	0.000	1.774	0.000	1.774	0.000	1.517	0.000	1.517
480.000	0.000	5.413	0.000	5.413	0.000	-1.834	0.000	1.834
520.000	0.000	4.233	0.000	4.233	0.000	.340	0.000	.340
560.000	0.000	.908	0.000	.908	0.000	.434	0.000	.434
600.000	0.000	-1.174	0.000	1.174	0.000	.361	0.000	.361
640.000	0.000	-2.780	0.000	2.780	0.000	.092	0.000	.092
680.000	0.000	-3.222	0.000	3.222	0.000	-.055	0.000	.055
720.000	0.000	-1.787	0.000	1.787	0.000	-.215	0.000	.215
760.000	0.000	.257	0.000	.257	0.000	-.167	0.000	.167
800.000	0.000	1.725	0.000	1.725	0.000	-.063	0.000	.063
840.000	0.000	2.306	0.000	2.306	0.000	-.007	0.000	.007
880.000	0.000	1.833	0.000	1.833	0.000	.061	0.000	.061
920.000	0.000	.953	0.000	.953	0.000	.119	0.000	.119
960.000	0.000	.035	0.000	.035	0.000	.122	0.000	.122
1000.000	0.000	-.781	0.000	.781	0.000	.093	0.000	.093
1040.000	0.000	-1.396	0.000	1.396	0.000	.054	0.000	.054
1080.000	0.000	-1.706	0.000	1.706	0.000	.001	0.000	.001
1120.000	0.000	-1.582	0.000	1.582	0.000	-.063	0.000	.063
1160.000	0.000	-1.021	0.000	1.021	0.000	-.102	0.000	.102
1200.000	0.000	-.287	0.000	.287	0.000	-.097	0.000	.097
1240.000	0.000	.427	0.000	.427	0.000	-.069	0.000	.069
1280.000	0.000	.996	0.000	.996	0.000	-.044	0.000	.044
1320.000	0.000	1.314	0.000	1.314	0.000	-.064	0.000	.064
1360.000	0.000	1.172	0.000	1.172	0.000	-.014	0.000	.014
1400.000	0.000	.977	0.000	.977	0.000	-.014	0.000	.014
1440.000	0.000	.841	0.000	.841	0.000	-.014	0.000	.014
1480.000	0.000	.776	0.000	.776	0.000	-.149	0.000	.149
1520.000	0.000	1.169	0.000	1.169	0.000	-.415	0.000	.415
1560.000	0.000	1.243	0.000	1.243	0.000	-.297	0.000	.297
1600.000	0.000	1.379	0.000	1.379	0.000	-.297	0.000	.297

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT

SEGMENT ANGULAR DISPLACEMENTS (DEG) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	YAW	PITCH	ROLL	RES	YAW	PITCH	ROLL	RES
0.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
40.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
80.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
120.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
160.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
200.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
240.000	0.000	7.601	0.000	7.601	0.000	12.001	0.000	12.001
280.000	0.000	-16.289	0.000	16.289	0.000	5.939	0.000	5.939
320.000	0.000	-50.313	0.000	50.313	0.000	16.005	0.000	16.005
360.000	0.000	-79.322	0.000	79.322	0.000	18.529	0.000	18.529
400.000	0.000	-90.987	0.000	90.987	0.000	19.290	0.000	19.290
440.000	0.000	-81.223	0.000	81.223	0.000	9.726	0.000	9.726
480.000	0.000	-28.411	0.000	28.411	0.000	.480	0.000	.480
520.000	0.000	47.885	0.000	47.885	0.000	-1.374	0.000	1.374
560.000	0.000	83.925	0.000	83.925	0.000	2.894	0.000	2.894
600.000	0.000	80.685	0.000	80.685	0.000	8.796	0.000	8.796
640.000	0.000	51.424	0.000	51.424	0.000	11.543	0.000	11.543
680.000	0.000	6.335	0.000	6.335	0.000	11.956	0.000	11.956
720.000	0.000	-31.745	0.000	31.745	0.000	9.665	0.000	9.665
760.000	0.000	-42.282	0.000	42.282	0.000	6.655	0.000	6.655
800.000	0.000	-27.439	0.000	27.439	0.000	5.043	0.000	5.043
840.000	0.000	3.033	0.000	3.033	0.000	4.548	0.000	4.548
880.000	0.000	33.628	0.000	33.628	0.000	4.922	0.000	4.922
920.000	0.000	53.885	0.000	53.885	0.000	6.280	0.000	6.280
960.000	0.000	60.920	0.000	60.920	0.000	8.075	0.000	8.075
1000.000	0.000	55.381	0.000	55.381	0.000	9.636	0.000	9.636
1040.000	0.000	39.401	0.000	39.401	0.000	10.698	0.000	10.698
1080.000	0.000	16.615	0.000	16.615	0.000	11.117	0.000	11.117
1120.000	0.000	-7.699	0.000	7.699	0.000	10.671	0.000	10.671
1160.000	0.000	-26.797	0.000	26.797	0.000	9.434	0.000	9.434
1200.000	0.000	-36.279	0.000	36.279	0.000	7.956	0.000	7.956
1240.000	0.000	-35.171	0.000	35.171	0.000	6.755	0.000	6.755
1280.000	0.000	-24.683	0.000	24.683	0.000	5.962	0.000	5.962
1320.000	0.000	-7.688	0.000	7.688	0.000	5.336	0.000	5.336
1360.000	0.000	10.625	0.000	10.625	0.000	5.124	0.000	5.124
1400.000	0.000	26.019	0.000	26.019	0.000	4.920	0.000	4.920
1440.000	0.000	39.036	0.000	39.036	0.000	4.716	0.000	4.716
1480.000	0.000	50.559	0.000	50.559	0.000	4.432	0.000	4.432
1520.000	0.000	64.358	0.000	64.358	0.000	2.612	0.000	2.612
1560.000	0.000	81.755	0.000	81.755	0.000	-1.753	0.000	1.753
1600.000	0.000	100.563	0.000	100.563	0.000	-6.036	0.000	6.036

RUN DESCRIPTION: 95TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 2)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(95%)-SEAT
0 SPRING DAMPER FORCES

	SPRING DAMPER NO. 1		SPRING DAMPER NO. 2	
	SEG 1(MS) - SEG 2(CH)		SEG 1(MS) - SEG 2(CH)	
TIME (MSEC)	LENGTH (IN)	FORCE (LB)	LENGTH (IN)	FORCE (LB)
0.000	10.196	0.00	10.196	0.00
40.000	10.196	0.00	10.196	0.00
80.000	10.196	0.00	10.196	0.00
120.000	10.196	0.00	10.196	0.00
160.000	10.196	0.00	10.196	0.00
200.000	10.196	0.00	10.196	0.00
240.000	11.503	0.00	11.503	0.00
280.000	37.143	0.00	37.143	0.00
320.000	28.203	0.00	28.203	0.00
360.000	52.979	1557.43	52.979	1557.43
400.000	57.732	2127.81	57.732	2127.81
440.000	78.456	4614.74	78.456	4614.74
480.000	90.106	6012.74	90.106	6012.74
520.000	92.990	6358.77	92.990	6358.77
560.000	79.971	4796.52	79.971	4796.52
600.000	74.207	4104.81	74.207	4104.81
640.000	72.427	3891.29	72.427	3891.29
680.000	71.036	3724.28	71.036	3724.28
720.000	68.011	3361.31	68.011	3361.31
760.000	62.913	2749.55	62.913	2749.55
800.000	61.188	2542.58	61.188	2542.58
840.000	60.133	2416.01	60.133	2416.01
880.000	59.320	2318.38	59.320	2318.38
920.000	57.476	2097.10	57.476	2097.10
960.000	55.851	1902.17	55.851	1902.17
1000.000	54.827	1779.23	54.827	1779.23
1040.000	54.039	1684.65	54.039	1684.65
1080.000	53.596	1631.57	53.596	1631.57
1120.000	52.706	1524.74	52.706	1524.74
1160.000	51.522	1382.58	51.522	1382.58
1200.000	50.445	1253.39	50.445	1253.39
1240.000	49.647	1157.62	49.647	1157.62
1280.000	49.040	1084.82	49.040	1084.82
1320.000	47.595	911.38	47.595	911.38
1360.000	27.474	0.00	27.474	0.00
1400.000	7.696	0.00	7.696	0.00
1440.000	19.910	0.00	19.910	0.00
1480.000	42.757	330.87	42.757	330.87
1520.000	43.093	371.21	43.093	371.21
1560.000	24.362	0.00	24.362	0.00
1600.000	31.165	0.00	31.165	0.00

1 ELAPSED CPU TIME = 13.70 SECONDS

SUB	CALLS	TIME	%
MAIN3D	1	5	.36
INPUT	1	11	.80
CHAIN	2124	13	.95
DINT	41	201	14.67
PDAUX	2549	215	15.69
DAUX	2123	197	14.38
SETUP1	2123	21	1.53
CONTCT	2123	73	5.33
	2123	104	7.59
WINDY	4246	120	8.76
SPDAMP	2123	70	5.11
VISPR	2123	22	1.61
EJOINT	2123	17	1.24
SETUP2	2123	7	.51
DAUX11	2123	23	1.68
DAUX12	2123	17	1.24
DAUX22	2123	24	1.75
FSMSOL	2123	16	1.17
OUTPUT	427	75	5.47
UPDATE	426	3	.22
DZP	2122	93	6.79
POSTPR	1	43	3.14
0TOTAL		1370	100.00

*EOR

```
1  CSA   NOS/BE L530H       L530H-CMR1 03/15/82
 18.12.07.GB19LMC  FROM    /9L
 18.12.07.IP  00000128 WORDS - FILE INPUT  , DC 04
 18.12.07.GB1,T30,1030,CM327000,STCSA.    L800764/
 18.12.07.BUTLER
 18.12.08.ACCOUNT TO BE CLOSED AT END OF MONTH
 18.12.08.CALL YOUR OCR
 18.12.08. INTERCOM BATCH JOB - NO DECK
 18.12.08.ATTACH,ATBM,ATBGBAIRFLOWBINARY1982,MR=1.
 18.12.09.AT CY= 001 SN=AFIT
 18.12.09.ATTACH,BPLT,CCPLOT56X,SN=ASD,ID=LIBRARY.
 18.12.09.AT CY= 999 SN=ASD
 18.12.09.ATTACH,AIRFLOW,ATBGBAIRFLOW95THINPUT,CY=
 18.12.09.11.
 18.12.09.ATTACH,TAPE10,SMAERO,ID=FDLTR7457,SN=AFF
 18.12.09.DL,MR=1.
 18.12.10.AT CY= 999 SN=AFFDL
 18.12.10.MAP,ON.
 18.12.10.LIBRARY,BPLT.
 18.12.10.LDSET,PRESET=ZERO.
 18.12.10.ATBM,AIRFLOW,FL=12000.
 18.16.01.    STOP  1
 18.16.01.    275600 MAXIMUM EXECUTION FL.
 18.16.01.    13.721 CP SECONDS EXECUTION TIME.
 18.16.01.OP  00018304 WORDS - FILE OUTPUT , DC 40
 18.16.01.MS   21888  WORDS  (   69312 MAX USED)
 18.16.01.CPA      15.359 SEC.        12.516 ADJ.
 18.16.01.IO       11.554 SEC.         3.420 ADJ.
 18.16.01.CM     2265.809 KWS.        10.673 ADJ.
 18.16.01.CRUS                        26.610
 18.16.01.COST                 $       1.75
 18.16.01.PP       7.654 SEC.     DATE 05/27/82
 18.16.01.EJ  END OF JOB, 9L  L800764.
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AFAMRL ARTICULATED TOTAL BODY (ATB-II) MODEL

DEVELOPED BY CALSPAN CORP., P.O. BOX 400, BUFFALO NY 14225
AND BY J & J TECHNOLOGIES INC., ORCHARD PARK NY 14127

FOR THE AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY,
AFSC AERONAUTICAL SYSTEMS DIVISION, WRIGHT-PATTERSON AFB
UNDER CONTRACTS F33615-75C-5002, -78C-0516 AND -80C-0511

AND FOR THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION,
U.S. DEPARTMENT OF TRANSPORTATION, UNDER CONTRACTS
FH-11-7592, HS-053-2-485, HS-6-01300 AND HS-6-01410.

PROGRAM DOCUMENTATION: NHTSA REPORT NOS. DOT-HS-801-507
THROUGH 510 (FORMERLY CALSPAN REPORT NO. ZQ-5180-L-1),
AVAILABLE FROM NTIS (ACCESSION NOS. PB-241692,3,4 AND 5),
APPENDIXES A-J TO THE ABOVE (AVAILABLE FROM CALSPAN),
AND REPORT NOS. AMRL-TR-75-14 AND AFAMRL-TR-80-14.

PROGRAM ATB-II, EXECUTED ON THE CDC CYBER COMPUTER SYSTEM,
AFSC ASD COMPUTER CENTER, WRIGHT-PATTERSON AFB, OHIO 45433

20-MAY-82 IRSIN= 0 IRSOUT= 0 RSTIME = 0.0000 CARDS A

5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

UNITL = IN UNITM = LB UNITT = SEC GRAVITY VECTOR = (0.0000, 0.0000, 386.0880)

NDINT = 6 NSTEPS = 40 DT = .040000 H0 = .000125 HMAX = .004000 HMIN = .000125

0 NPRT ARRAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

1 CRASH VICTIM SINGLE MAN(5%)-SEAT 2 SEGMENTS 1 JOINTS CARD B.1

CARDS B.2

SEGMENT			WEIGHT	PRINCIPAL MOMENTS OF INERTIA (LB - SEC**2- IN)			SEGMENT CONTACT ELLIPSOID SEMIAXES (IN)			CENTER (IN)			PRINCIPAL AXES (DEG)		
I	SYM	PLOT	(LB)	X	Y	Z	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL
1	MS	M	298.900	197.0400	186.1200	50.1650	144.000	6.480	34.460	-5.040	.110	8.140	0.00	-20.84	0.00
2	CH	C	25.000	25.0000	20.0000	25.0000	38.400	38.400	38.400	0.000	0.000	0.000	0.00	0.00	0.00

CARDS B.3

JOINT					LOCATION(IN) - SEG(JNT)			LOCATION(IN) - SEG(J+1)			PRIN. AXIS(DEG) - SEG(JNT)			PRIN. AXIS(DEG) - SEG(J+1)		
J	SYM	PLOT	JNT	PIN	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL	YAW	PITCH	ROLL
1	NULL	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00

1 JOINT TORQUE CHARACTERISTICS

CARDS B.4

	FLEXURAL SPRING CHARACTERISTICS					TORSIONAL SPRING CHARACTERISTICS				
	SPRING COEF. (IN LB /DEG**J)			ENERGY	JOINT	SPRING COEF. (IN LB /DEG**J)			ENERGY	JOINT
JOINT	LINEAR	QUADRATIC	CUBIC	DISSIPATION	STOP	LINEAR	QUADRATIC	CUBIC	DISSIPATION	STOP
	(J=1)	(J=2)	(J=3)	COEF.	(DEG)	(J=1)	(J=2)	(J=3)	COEF.	(DEG)
1 NULL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CARDS B.5

JOINT VISCOUS CHARACTERISTICS AND LOCK-UNLOCK CONDITIONS

JOINT	VISCOUS COEFFICIENT (IN LB SEC/DEG)	COULOMB FRICTION COEF. (IN LB)	FULL FRICTION ANGULAR VELOCITY (DEG/ SEC)	MAX TORQUE FOR A LOCKED JOINT (IN LB)	MIN TORQUE FOR UNLOCKED JOINT (IN LB)	MIN. ANG. VELOCITY FOR UNLOCKED JOINT (RAD/ SEC)	IMPULSE RESTITUTION COEFFICIENT
1 NULL	0.000	0.00	0.00	0.00	0.00	0.00	0.000

SEGMENT INTEGRATION CONVERGENCE TEST INPUT

SEGMENT NO.	SYM	ANGULAR VELOCITIES (RAD/ SEC) MAG. TEST	ABS. ERROR	REL. ERROR	LINEAR VELOCITIES (IN / SEC) MAG. TEST	ABS. ERROR	REL. ERROR	ANGULAR ACCELERATIONS (RAD/ SEC**2) MAG. TEST	ABS. ERROR	REL. ERROR	LINEAR ACCELERATIONS (IN / SEC**2) MAG. TEST	ABS. ERROR	REL. ERROR
1	MS	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000
2	CH	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000

1 VEHICLE DECELERATION INPUTS CARDS C

AIRFRAME

YAW	PITCH	ROLL	VIPS	VTIME	X0(X)	X0(Y)	X0(Z)	NATAB	AT0	ADT	MSEG
0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0	0.000000	0.000000	0

0 PASSENGER COMPARTMENT DISPLACEMENT HISTORY
ANALYTICAL HALF-SINE WAVE DECELERATION
V0= 0.000 IN / SEC, OBLIQUE ANGLES = 0.00 0.00 0.00 DEGREES, TIME DURATION = 1.000 SEC

1 NPL	NBLT	NBAG	NELP	NQ	NSD	NHRNSS	NWINDF	NJNTF	NFORCE	CARD D.1
1	0	0	0	0	2	0	1	0	4	

0 PLANE INPUTS — CARDS D.2

0 PLANE NO. 1 EJEC PLANE

	X	Y	Z
POINT 1	30.0000	30.0000	-100.0000
POINT 2	-30.0000	30.0000	-100.0000
POINT 3	-30.0000	-30.0000	-100.0000

0 BODY SEGMENT SYMMETRY INPUT — CARD D.7

SEG NO.	1	2
0 NSYM(J)	0	0

0 SPRING DAMPERS FUNCTION INPUT — CARDS D.8

COORDINATES OF ATTACHMENT POINTS (IN)

SEGMENT			SEGMENT M			SEGMENT N			SPRING FORCE FUNCTION			DAMPING FORCE FUNCTION	
NO.	M	N	X	Y	Z	X	Y	Z	D0	A1	A2	B1	B2
1	1	2	-11.64	6.23	-4.34	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000
2	1	2	-11.64	-6.01	-4.34	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000

0 FORCE FUNCTIONS INPUT — CARDS D.9

NO.	SEG	FCN1	FCN2	X	Y	Z	YAW	PITCH	ROLL
1	1	1	0	-9.468	.110	8.488	0.000	40.750	0.000
2	1	-2	3	-2.530	.110	16.540	0.000	77.600	0.000
3	1	4	0	-10.440	-2.386	-8.000	0.000	-30.000	0.000
4	2	5	0	0.000	0.000	0.000	0.000	150.000	0.000

1FUNCTION NO. 1 SUSTAINER ROCKET NTI(1) = 1 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 9 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.214000	3425.0000
.243000	3680.0000
.354000	3400.0000
.494000	3150.0000
.605000	1000.0000
.653000	0.0000
1.600000	0.0000

0FUNCTION NO. 2 STAPAC ROCKET NTI(2) = 25 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 12 TABULAR POINTS

D	F(D)
0.000000	0.0000
.198000	0.0000
.199000	23.4000
.203000	890.6000
.204000	703.1000
.428000	723.8000
.698000	492.2000
.742000	515.6000
.755000	445.3000
.779000	82.0000
.800000	0.0000
1.600000	0.0000

1FUNCTION NO. 3 STAPAC PITCH VS RATE NTI(3) = 55 CARDS E

D0	D1	D2	D3	D4
-6.2830	-6.2830	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 4 TABULAR POINTS

D	F(D)
-6.283000	-.7854
-1.571000	-.7854
1.571000	.7854
6.283000	.7854

0FUNCTION NO. 4 DROGUE GUN ON SEAT NTI(4) = 69 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	1756.0000
.216000	1756.0000
.217000	0.0000
1.600000	0.0000

1FUNCTION NO. 5 DROGUE GUN ON CHUTE NTI(5) = 87 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	2200.0000
.216000	2200.0000
.217000	0.0000
1.600000	0.0000

0FUNCTION NO. 6 CHUTE CA FUNCTION NTI(6) = 105 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 8 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.355000	.0300
.478000	.4600
.500000	.4600
1.300000	.4600
1.316000	0.0000
1.600000	0.0000

1 WIND FORCE FUNCTION NO. 41   WIND FORCE ON CHUTE   NTI(41) = 127   CARDS E.6

D0	D1	D2	D3	D4
0.0000	0.0000	0.0000	0.0000	0.0000

0 WIND FORCE TABLES FOR 2 TIME POINTS.

T	FX(T)	FY(T)	FZ(T)
0.000000	0.	0.	0.
.001000	-10.0000	0.	0.

1 ALLOWED CONTACTS AND ASSOCIATED FUNCTIONS

	SEGMENT-ELLIPSOID	SEGMENT-PLANE	WIND FORCE FUNCTION
0	2 - -2	3 - 1	6
	CH	VEH - EJEC PLANE	CHUTE CA FUNCTION

1 SUBROUTINE INITAL INPUT CARD G.1

ZPLT(X)	ZPLT(Y)	ZPLT(Z)	I1	J1	I2	J2	I3	SPLT(1)	SPLT(2)	SPLT(3)
1.	1.	1.	0	0	0	0	1	10.00	6.00	1.00

0 INITIAL POSITIONS (INERTIAL REFERENCE) CARDS G.2

SEGMENT		LINEAR POSITION (IN)			LINEAR VELOCITY (IN / SEC)		
NO.	SEG	X	Y	Z	X	Y	Z
1	MS	3.15871	-.11000	-9.03791	-122.40370	0.00000	-634.36440
2	CH	-178.01766	-.11000	34.84606	-122.40370	0.00000	-634.36440

0 INITIAL ANGULAR ROTATION AND VELOCITY CARDS G.3

SEGMENT		ANGULAR ROTATION (DEG)			ANGULAR VELOCITY (DEG/ SEC)			IYPR			
NO.	SEG	YAW	PITCH	ROLL	X	Y	Z				
1	MS	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0
2	CH	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0

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1    TIME          MACH    ALPHA     BETA          CX        CY        CZ           CL         CM         CN


 CARD H.1  3      1  1  2
 CARD H.2  3      1  1  2
 CARD H.3  3      1  1  2
 CARD H.4  2      1  2
 CARD H.5  2      1  2
 CARD H.6  2      1  2
 CARD H.7  0      0
   214.00          .9005     9.85     -.01      -7761.25      1.93   1927.12        193.91 -47397.14     869.90
   240.00          .8829     4.83    -1.03      -7786.27    120.36   2377.47      -1057.04 -49497.03    1999.58
   280.00          .8625   -18.16    -4.40      -7626.20    -54.44   2995.71       -826.75 -29445.18    2679.23
0 DINT CONV. TEST   288.000   CH   ANG ACC   4803.        9166.        .2259       .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .288000 FOR H =   .004000
   320.00          .8541   -50.62    -6.20      -6130.54     14.71   4087.74       2574.18   1968.43    -124.09
   360.00          .8540   -75.60     -.50      -3330.59     28.48   3677.53        947.83   9224.74     152.22
   400.00          .8399   -75.52    10.13      -3313.64   -709.89   3804.01      -7638.71   5070.39    2798.89
   440.00          .8206   -39.65      .92      -6452.61    -33.95   3459.86        115.88  -5719.88     435.84
0 DINT CONV. TEST   452.000   CH   ANG ACC   .7006E+07   .2016E+06   .2376E-01   .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .452000 FOR H =   .004000
0 DINT CONV. TEST   464.000   CH   ANG ACC   .2249E+07   .6663E+06   .2873       .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .464000 FOR H =   .004000
   480.00          .7689     5.41   -52.11      -3752.46   6732.87   1478.35     -30684.68 -25570.36   27722.95
0 DINT CONV. TEST   488.000   CH   ANG ACC   .9210E+07   .9050E+06   .9800E-01   .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .488000 FOR H =   .004000
0 DINT CONV. TEST   492.000   CH   ANG ACC   .9554E+06   .1242E+06   .1283       .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .492000 FOR H =   .004000
0 DINT CONV. TEST   504.000   CH   ANG ACC   .6337E+06   .1361E+05   .2146E-01   .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .504000 FOR H =   .004000
0 DINT CONV. TEST   516.000   CH   ANG ACC   .2223E+07   .2760E+05   .1232E-01   .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .516000 FOR H =   .004000
   520.00          .7004    57.17    16.65      -1312.18  -2570.09  -2750.69      12007.76  14565.39   -9516.31
0 DINT CONV. TEST   544.000   CH   ANG ACC   .1094E+07   .1688E+05   .1536E-01   .1000E-05  .1000E-01  .1000E-01
0 TEST FAILED AT TIME =    .544000 FOR H =   .004000
   560.00          .6389    91.28    31.25        970.96  -1832.22  -2554.61      12224.79  23614.57   -7080.54
   600.00          .5943    66.69    -3.70       -985.29    423.53  -1970.78      -1824.65  11320.68    1866.30
   640.00          .5486    33.81   -40.39      -1881.07   2338.27    -80.50     -17700.84  -8603.35    9922.54
   680.00          .5193   -13.70     4.61      -2315.67     45.37    936.92        664.02 -11274.00    -255.88
   720.00          .4991   -48.87    33.28      -1467.22  -1513.80   1092.23         97.58  -2546.87   -3613.67
   760.00          .4774   -32.84    27.42      -1715.07   -989.96    898.90       2259.72  -4096.96   -3695.90
   800.00          .4603   -10.94   -15.54      -1852.25    358.86    724.40      -2779.41  -8556.67    2832.37
   840.00          .4347     8.49   -43.88      -1434.43   1685.55    593.67      -9976.17 -11169.77    8259.40
   880.00          .4143    31.30   -25.75      -1250.24    870.89    -89.03      -7178.27  -6174.10    4217.24
   920.00          .3957    43.83    10.86       -730.33   -221.51   -511.15        708.26  -1622.40   -1158.60
   960.00          .3763    50.89    28.27       -730.28   -756.71   -397.75       5148.16   -391.95   -3280.76
  1000.00          .3614    44.23    21.77       -782.60   -506.96   -312.25       3410.07  -2036.77   -2212.36
  1040.00          .3454    29.45    -3.03       -617.00     64.71   -180.33        217.66  -3631.46     206.07
  1080.00          .3309     9.45   -23.63      -1047.28    488.29    313.63      -4231.15  -7210.62    3151.42
  1120.00          .3196   -11.79   -18.93       -865.44    246.46    352.38      -1729.46  -3939.46    1701.50
  1160.00          .3117   -23.24     1.96       -813.86     -1.60    361.97         67.70  -2852.42      -2.28
  1200.00          .3044   -26.63    21.05       -751.00   -272.11    357.81        993.05  -2317.63   -1192.84
  1240.00          .2965   -17.57    27.45       -681.15   -377.57    313.24       2060.03  -2992.94   -1872.95
  1280.00          .2883     -.08    13.94       -840.53   -160.50    322.27       1336.17  -5909.72   -1138.84
```

1320.00	.2797	13.85	-13.05	-710.29	192.52	143.50	-1485.08	-4726.10	1174.46
1360.00	.2745	26.30	-37.49	-548.97	555.36	64.99	-4195.81	-3223.60	2665.07
1400.00	.2707	47.99	-64.91	-322.74	625.04	-123.84	-4550.97	-342.84	2455.63
1440.00	.2671	154.51	-72.33	452.40	504.53	-181.02	-3478.28	595.79	389.39
1480.00	.2629	-171.53	-40.95	473.86	447.63	-11.61	-2263.77	-1729.78	-56.45
1520.00	.2613	-162.21	-6.60	370.26	-5.88	-6.84	-678.81	-2615.53	390.80
1560.00	.2651	-154.87	26.58	485.97	-275.13	7.18	578.37	-2601.69	18.47
1600.00	.2620	-141.39	52.80	416.61	-553.17	24.83	144.66	-2089.67	143.67

1 DATE: 20-MAY-82 PAGE: 21.01

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT LINEAR ACCELERATIONS (G"S) IN LOCAL REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-5.04, .11, 8.14) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
40.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
80.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
120.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
160.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
200.000	-.044	0.000	.191	.196	-.023	.002	.218	.220	-.216	0.000	.976	1.000
240.000	-16.068	.398	-10.099	18.982	-18.619	.041	-14.805	23.787	-8.591	0.000	-.373	8.599
280.000	-16.087	-.240	-7.856	17.904	-14.589	-1.196	-12.179	19.042	-20.349	0.000	-.240	20.350
320.000	-12.519	-.176	-2.711	12.811	-8.110	-1.257	-3.706	9.005	-29.628	-.097	-6.323	30.295
360.000	-3.037	-1.275	6.795	7.551	1.682	-2.800	11.055	11.528	34.665	.875	-20.446	40.255
400.000	-6.206	-8.198	13.171	16.709	-.075	-12.336	19.554	23.120	-49.321	-13.653	-63.523	81.573
440.000	-37.284	-5.364	11.061	39.259	-7.799	-7.321	16.462	19.632	-25.844	-8.327	-10.218	29.011
480.000	-30.813	57.977	-11.420	66.642	-21.812	83.754	-21.535	89.186	7.296	9.642	62.519	63.678
520.000	-11.025	-17.959	-44.342	49.095	12.629	-28.322	-51.012	59.698	-53.722	-11.503	.961	54.948
560.000	14.515	-21.838	-34.931	43.678	11.132	-36.874	-41.466	56.596	-56.331	-25.761	2.320	61.986
600.000	-4.397	2.468	-30.129	30.548	-1.497	.340	-30.537	30.576	-47.046	-.987	16.227	49.775
640.000	-18.541	23.842	-13.433	33.056	-13.402	36.722	-22.777	45.243	-3.662	5.827	19.695	20.862
680.000	-24.237	-1.429	3.677	24.556	-6.477	-4.088	-.982	7.721	-34.152	-5.869	14.706	37.644
720.000	-14.849	-15.602	12.162	24.736	-9.006	-26.179	17.026	32.501	-14.917	-3.357	3.096	15.600
760.000	-16.377	-7.724	4.875	18.752	-8.857	-12.159	11.241	18.779	-55.669	5.877	-7.453	56.472
800.000	-21.093	7.868	3.458	22.777	-9.587	14.492	7.204	18.811	19.133	6.554	-14.788	25.054
840.000	-12.069	15.393	-.438	19.565	-10.059	23.404	-2.658	25.686	-35.782	.246	-8.178	36.706
880.000	-10.130	8.025	-5.738	14.140	-6.842	11.676	-7.620	15.531	-23.433	-2.773	4.835	28.974
920.000	-11.133	-2.858	-11.757	16.442	-8.001	-6.072	-14.967	18.025	20.959	-1.245	13.838	25.146
960.000	-6.405	-6.072	-7.304	11.456	-6.884	-10.403	-9.612	15.748	-39.013	2.219	11.463	40.723
1000.000	-7.869	-4.461	-6.721	11.269	-8.118	-8.525	-8.366	14.442	-11.845	1.735	3.899	12.590
1040.000	-10.327	1.279	-5.079	11.579	-8.899	.639	-5.424	10.442	3.342	-.867	-2.703	4.384
1080.000	-10.297	5.086	-.035	11.485	-9.262	7.550	-.911	11.984	-15.848	-2.444	-5.581	16.978
1120.000	-9.013	3.050	2.775	9.911	-6.749	4.976	1.520	8.522	-12.593	-1.232	-4.507	13.432
1160.000	-8.750	-.534	4.126	9.689	-5.754	-1.269	3.388	6.797	-5.400	.876	-2.796	6.143
1200.000	-6.934	-3.490	3.586	8.551	-5.365	-6.232	3.556	8.959	-12.903	1.605	-.836	13.030
1240.000	-6.176	-4.272	2.169	7.816	-5.236	-6.942	3.083	9.225	-13.430	.578	1.184	13.495
1280.000	-7.953	-2.617	.363	8.380	-6.101	-3.312	1.714	7.151	4.704	-.493	3.763	6.044
1320.000	-7.348	1.118	-1.566	7.595	-5.345	3.665	-1.212	6.593	61.013	.045	.730	61.017
1360.000	-2.305	1.053	-.750	2.643	-.468	1.460	-.807	1.732	.173	.012	.985	1.000
1400.000	-1.525	1.649	-1.375	2.633	1.296	2.093	-1.109	2.701	.273	.010	.962	1.000
1440.000	.893	1.808	-1.115	2.304	4.517	2.704	-1.234	5.407	-.052	-.221	-2.962	2.970
1480.000	1.272	1.862	-.376	2.286	4.946	2.308	-1.167	5.581	.275	.008	.961	1.000
1520.000	-5.230	-.965	-1.663	5.572	-.877	-2.734	-2.474	3.790	-80.352	2.977	15.204	81.832
1560.000	1.967	-.702	-.266	2.105	4.837	-.815	-1.846	5.241	-.009	.029	.972	.972
1600.000	1.732	-1.928	-.312	2.610	4.662	-2.027	-1.824	5.401	.252	.049	.966	1.000

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT LINEAR VELOCITIES (IN / SEC) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-5.04, .11, 8.14) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-122.404	0.000	-634.364	646.066	-122.404	0.000	-634.364	646.066	-122.404	0.000	-634.364	646.066
40.000	-122.404	0.000	-618.921	630.909	-122.404	0.000	-618.921	630.909	-122.404	0.000	-618.921	630.909
80.000	-122.404	0.000	-603.477	615.766	-122.404	0.000	-603.477	615.766	-122.404	0.000	-603.477	615.766
120.000	-122.404	0.000	-588.034	600.638	-122.404	0.000	-588.034	600.638	-122.404	0.000	-588.034	600.638
160.000	-122.404	0.000	-572.590	585.527	-122.404	0.000	-572.590	585.527	-122.404	0.000	-572.590	585.527
200.000	-122.404	0.000	-557.354	570.636	-122.397	.000	-557.348	570.629	-122.404	0.000	-557.147	570.434
240.000	-298.740	.288	-640.136	706.414	-338.104	-4.572	-679.027	758.560	-339.612	0.000	-593.954	684.191
280.000	-532.991	-8.961	-787.175	950.686	-579.593	-24.903	-895.416	1066.920	-563.256	0.000	-567.447	799.533
320.000	-702.857	-42.880	-968.431	1197.375	-685.461	-73.487	-1086.707	1286.930	-956.100	-.230	-555.202	1105.612
360.000	-768.609	-82.284	-1060.068	1311.974	-732.968	-100.840	-1112.462	1336.033	-1208.940	-10.937	-644.601	1370.098
400.000	-961.865	-126.376	-1005.277	1397.046	-992.158	-131.085	-951.303	1380.774	-1344.555	-122.689	-1499.281	2017.603
440.000	-1318.109	-284.912	-935.633	1641.339	-1313.426	-87.787	-746.779	1513.431	-2410.029	-286.605	-1814.207	3030.137
480.000	-2133.887	-474.835	-843.047	2343.005	-1977.396	-373.086	-957.960	2228.671	-2104.841	-311.391	-1281.288	2483.751
520.000	-2960.437	-636.511	-794.504	3130.586	-2788.997	-789.754	-973.392	3057.729	-2728.309	-277.611	-777.899	2850.591
560.000	-3669.599	-618.891	-523.109	3758.008	-3683.450	-685.710	-549.885	3786.869	-3312.570	-566.366	-761.910	3445.925
600.000	-4173.691	-575.609	-312.342	4224.758	-4260.232	-531.376	-321.028	4305.229	-4407.353	-658.092	-560.376	4491.310
640.000	-4665.381	-588.295	-235.189	4708.204	-4845.664	-626.766	-195.956	4889.959	-4498.537	-584.488	-266.799	4544.188
680.000	-5100.865	-561.513	-215.508	5136.201	-5157.061	-694.357	-10.759	5203.607	-5044.726	-538.852	-22.597	5073.474
720.000	-5489.223	-499.008	-165.602	5514.345	-5460.144	-507.028	-89.578	5484.367	-5211.177	-612.775	111.387	5248.263
760.000	-5797.471	-426.134	-111.081	5814.165	-5835.290	-386.875	-181.913	5850.930	-5916.940	-535.231	72.096	5941.536
800.000	-6100.669	-379.365	-62.590	6112.805	-6037.232	-460.372	-183.387	6057.536	-6210.902	-406.784	-97.360	6224.970
840.000	-6444.664	-360.262	-17.146	6454.749	-6379.986	-427.727	25.379	6394.358	-6166.479	-355.040	-303.050	6184.121
880.000	-6680.641	-356.590	20.730	6690.183	-6648.910	-371.494	132.533	6660.599	-6913.379	-329.611	-276.113	6926.737
920.000	-6913.146	-331.590	31.847	6921.167	-6860.416	-282.465	138.359	6867.622	-6821.029	-375.173	-115.264	6832.311
960.000	-7137.787	-322.830	24.103	7145.124	-7135.390	-273.780	63.458	7140.922	-6964.475	-357.750	83.599	6974.158
1000.000	-7301.521	-325.573	23.516	7308.814	-7351.651	-300.885	26.699	7357.854	-7480.546	-296.900	163.158	7488.213
1040.000	-7482.698	-316.333	29.046	7489.438	-7544.863	-316.234	-4.572	7551.489	-7449.748	-291.535	170.774	7457.406
1080.000	-7663.230	-300.537	50.999	7669.341	-7715.634	-274.156	12.721	7720.514	-7558.799	-311.617	102.100	7565.908
1120.000	-7825.001	-290.034	69.785	7830.686	-7867.090	-220.734	16.785	7870.204	-7814.967	-319.629	31.420	7821.563
1160.000	-7977.477	-286.228	78.036	7982.992	-7976.339	-201.567	20.452	7978.911	-7935.789	-312.195	-20.217	7941.953
1200.000	-8119.576	-281.245	80.058	8124.840	-8092.866	-228.023	44.791	8096.202	-8068.355	-283.226	-43.746	8073.443
1240.000	-8244.251	-281.440	85.889	8249.500	-8226.756	-258.747	84.592	8231.259	-8289.793	-252.885	-36.727	8293.731
1280.000	-8365.175	-276.944	95.318	8370.300	-8343.110	-254.676	133.419	8348.062	-8434.260	-244.502	-.553	8437.803
1320.000	-8488.696	-266.244	103.648	8493.592	-8432.273	-233.056	129.977	8436.495	-8252.232	-265.458	78.501	8256.874
1360.000	-8549.293	-257.038	112.428	8553.895	-8478.689	-234.320	110.383	8482.645	-7992.921	-283.606	121.203	7998.869
1400.000	-8587.799	-249.528	123.839	8592.316	-8505.127	-247.514	95.006	8509.258	-7992.921	-263.506	136.647	7999.118
1440.000	-8619.683	-255.089	137.607	8624.555	-8546.500	-287.447	70.757	8551.625	-7990.818	-284.004	145.111	7997.150
1480.000	-8653.266	-254.769	143.708	8658.209	-8620.884	-323.964	61.802	8627.191	-7990.522	-234.072	159.442	7997.159
1520.000	-8655.452	-251.554	158.070	8660.549	-8673.871	-349.483	89.164	8681.367	-8274.604	-276.748	147.585	8290.546
1560.000	-8594.333	-258.124	180.672	8600.107	-8651.058	-348.348	155.684	8659.469	-9263.932	-176.594	68.502	9265.868
1600.000	-8626.736	-258.241	199.975	8632.917	-8704.491	-333.289	217.969	8713.596	-9279.845	-166.434	57.965	9281.518

1 DATE: 20-MAY-82

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT LINEAR DISPLACEMENTS (IN) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-5.04, .11, 8.14) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	3.159	-.110	-9.038	9.575	-.000	0.000	-.000	.000	-178.018	-.110	34.846	181.396
40.000	-1.737	-.110	-34.104	34.148	-4.896	0.000	-25.066	25.539	-182.914	-.110	9.780	183.175
80.000	-6.634	-.110	-58.552	58.926	-9.792	0.000	-49.514	50.473	-187.810	-.110	-14.668	188.382
120.000	-11.530	-.110	-82.382	83.185	-14.688	0.000	-73.344	74.800	-192.706	-.110	-38.498	196.514
160.000	-16.426	-.110	-105.594	106.864	-19.585	0.000	-96.556	98.523	-197.602	-.110	-61.710	207.014
200.000	-21.322	-.110	-128.189	129.950	-24.481	0.000	-119.151	121.640	-202.498	-.110	-84.305	219.347
240.000	-28.502	-.107	-151.678	154.333	-32.370	-.021	-142.920	146.540	-212.438	-.110	-107.726	238.190
280.000	-45.408	-.169	-180.002	185.641	-52.254	-.220	-173.309	181.015	-229.838	-.110	-130.983	264.535
320.000	-70.483	-1.148	-215.140	226.394	-79.755	-1.687	-212.814	227.274	-259.770	-.119	-153.793	301.882
360.000	-99.903	-3.768	-256.192	275.008	-109.263	-4.874	-257.881	280.116	-306.218	-.284	-176.671	353.523
400.000	-134.145	-7.658	-297.539	326.470	-143.379	-8.244	-300.002	332.606	-351.805	-2.815	-219.600	414.728
440.000	-178.708	-15.459	-336.646	381.453	-187.765	-12.353	-336.612	385.637	-429.200	-10.914	-237.604	516.767
480.000	-245.995	-30.776	-371.602	446.709	-248.320	-21.514	-372.306	448.037	-521.673	-23.913	-352.372	629.985
520.000	-349.200	-53.051	-405.319	537.623	-345.011	-45.818	-409.989	537.794	-614.164	-35.023	-390.870	728.837
560.000	-482.117	-78.644	-431.630	651.864	-475.071	-75.301	-437.186	649.995	-734.648	-51.410	-421.770	848.670
600.000	-639.583	-102.335	-447.942	787.522	-634.394	-100.975	-455.873	787.700	-839.631	-77.017	-443.787	999.392
640.000	-816.049	-125.599	-458.479	944.412	-816.178	-125.154	-468.043	949.143	-1070.267	-102.035	-465.530	1171.581
680.000	-1011.918	-148.812	-467.547	1124.599	-1019.041	-150.997	-473.561	1133.801	-1259.231	-124.092	-470.994	1350.147
720.000	-1223.711	-170.164	-475.190	1323.718	-1231.974	-174.939	-475.967	1332.257	-1465.567	-147.107	-468.673	1545.698
760.000	-1449.793	-188.623	-480.817	1539.047	-1457.788	-193.890	-480.581	1547.158	-1685.801	-170.684	-464.581	1756.956
800.000	-1687.488	-204.643	-484.165	1767.458	-1694.259	-211.242	-485.672	1775.110	-1932.484	-189.346	-464.507	1996.525
840.000	-1938.529	-219.353	-485.768	2010.468	-1941.886	-228.257	-486.827	2014.949	-2176.910	-204.382	-473.182	2237.099
880.000	-2201.313	-233.708	-485.655	2266.331	-2201.923	-243.153	-484.207	2267.608	-2439.013	-217.935	-485.270	2496.351
920.000	-2473.084	-247.550	-484.459	2532.217	-2471.623	-256.064	-480.329	2530.850	-2716.387	-231.890	-493.618	2770.594
960.000	-2754.395	-260.548	-483.335	2808.592	-2752.074	-267.584	-477.271	2805.940	-2988.702	-246.952	-493.861	3039.280
1000.000	-3043.178	-273.527	-482.413	3093.295	-3041.681	-279.187	-474.837	3091.155	-3279.226	-259.926	-488.687	3325.613
1040.000	-3338.869	-286.412	-481.374	3385.528	-3339.660	-290.881	-472.943	3385.501	-3578.588	-271.512	-481.692	3621.055
1080.000	-3641.796	-298.741	-479.816	3685.397	-3645.465	-301.847	-471.536	3688.207	-3877.702	-283.581	-476.113	3917.100
1120.000	-3951.664	-310.543	-477.354	3992.437	-3958.060	-311.370	-470.276	3998.043	-4185.373	-296.252	-473.503	4222.478
1160.000	-4267.728	-322.067	-474.374	4306.073	-4275.503	-319.780	-469.275	4313.051	-4500.787	-308.960	-473.350	4536.144
1200.000	-4589.730	-333.397	-471.207	4625.885	-4597.070	-328.200	-467.921	4632.463	-4820.462	-320.924	-474.740	4854.402
1240.000	-4917.045	-344.650	-467.907	4951.268	-4923.037	-337.493	-465.776	4956.525	-5147.599	-331.598	-476.438	5180.225
1280.000	-5249.214	-355.846	-464.282	5281.707	-5253.558	-347.471	-462.652	5285.325	-5482.526	-341.463	-477.302	5513.847
1320.000	-5586.315	-366.712	-460.293	5617.229	-5588.571	-357.485	-459.098	5618.780	-5819.670	-351.443	-475.903	5849.662
1360.000	-5927.347	-377.169	-455.987	5956.814	-5927.414	-367.595	-455.943	5956.278	-6141.308	-362.656	-471.593	6170.055
1400.000	-6270.097	-387.289	-451.301	6298.237	-6268.287	-378.028	-452.919	6295.983	-6461.024	-374.000	-466.436	6488.627
1440.000	-6614.260	-397.315	-446.020	6641.176	-6611.101	-389.117	-449.826	6637.802	-6780.737	-385.345	-460.674	6807.284
1480.000	-6959.714	-407.572	-440.429	6985.535	-6956.153	-401.196	-446.622	6982.012	-7100.358	-396.708	-454.606	7125.947
1520.000	-7306.256	-417.658	-434.400	7331.066	-7303.291	-413.590	-442.544	7328.367	-7421.866	-408.133	-448.441	7446.595
1560.000	-7650.814	-427.891	-427.555	7674.689	-7649.200	-426.366	-436.868	7673.519	-7777.451	-416.715	-444.990	7801.309
1600.000	-7995.207	-438.227	-419.949	8018.213	-7995.360	-439.173	-429.476	8018.922	-8148.378	-423.547	-442.536	8171.370

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT ANGULAR ACCELERATIONS (REV/ SEC**2) IN LOCAL REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	-.024	.220	.004	.222	0.000	0.000	0.000	0.000
240.000	-3.736	-33.929	4.595	34.442	0.000	-10.318	0.000	10.318
280.000	-7.576	-16.381	5.913	18.992	0.000	-9.429	0.000	9.429
320.000	-4.985	11.684	-1.910	12.846	.002	-55.617	.592	55.620
360.000	-5.709	40.566	8.968	41.936	.562	-154.141	112.612	190.896
400.000	-20.488	46.619	62.213	80.396	-.705	-32.149	-84.422	90.339
440.000	46.621	42.638	78.063	100.426	.020	442.949	182.588	479.106
480.000	83.952	-.487	-318.874	329.741	.178	-434.705	165.427	465.118
520.000	-75.715	-83.798	49.613	123.355	.109	55.223	-30.972	63.315
560.000	-51.738	-41.176	156.349	169.757	.003	-72.157	-46.280	85.723
600.000	-21.264	-1.353	-14.248	25.631	.160	-54.681	40.889	68.278
640.000	48.871	-20.145	-150.262	159.289	-.023	-11.457	17.526	20.939
680.000	27.837	2.505	43.208	51.460	-.016	-17.092	-17.327	24.338
720.000	-40.725	50.403	110.668	128.244	-.021	-15.313	16.215	22.302
760.000	-8.707	30.639	53.154	61.967	-.067	10.436	-7.367	12.774
800.000	42.230	16.223	-49.676	67.188	.014	-12.770	-9.376	15.842
840.000	23.814	-3.927	-85.685	89.020	-.018	-5.270	4.336	6.825
880.000	-1.871	-12.989	-48.473	50.218	-.032	-3.324	4.916	5.935
920.000	-17.958	-29.712	31.793	47.075	.025	7.424	5.844	9.448
960.000	-12.894	-14.529	45.646	49.607	-.002	5.225	-.066	5.225
1000.000	-16.152	-8.989	36.809	41.190	.009	2.929	-1.309	3.208
1040.000	-6.898	.425	-8.195	10.714	.027	-1.124	.428	1.203
1080.000	4.923	4.315	-34.890	35.499	.005	-3.126	1.597	3.510
1120.000	8.159	5.802	-24.639	26.596	-.001	-1.005	.475	1.111
1160.000	.438	7.737	5.429	9.462	.003	-1.222	.114	1.227
1200.000	-7.536	10.324	26.993	29.866	.001	-.816	-1.210	1.460
1240.000	-6.245	12.363	29.533	32.620	-.008	-1.870	-2.030	2.760
1280.000	2.811	9.479	16.427	19.173	-.011	-1.825	2.804	3.346
1320.000	13.805	2.603	-15.697	21.065	.011	9.348	.928	9.394
1360.000	1.539	-.056	9.153	9.281	.030	0.000	-.004	.030
1400.000	2.886	.777	9.272	9.742	.030	0.000	-.004	.030
1440.000	8.098	-2.246	1.997	8.638	-.010	136.687	-6.424	136.838
1480.000	6.578	-7.204	2.981	10.201	-.011	0.000	.004	.012
1520.000	-2.863	-7.757	23.271	24.696	-.092	-498.735	83.098	505.610
1560.000	.739	-11.145	.257	11.173	-.868	.620	-.124	1.074
1600.000	-3.232	-10.157	-1.254	10.732	.020	0.000	.006	.021

1 DATE: 20-MAY-82

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT ANGULAR VELOCITIES (REV/ SEC) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	-.000	.000	.000	.000	0.000	0.000	0.000	0.000
240.000	-.047	-.919	.162	.935	0.000	-.144	0.000	.144
280.000	-.250	-1.975	.398	2.031	0.000	-.651	0.000	.651
320.000	-.634	-2.088	.447	2.227	-.000	.227	-.006	.227
360.000	-.667	-1.237	-.016	1.405	-.040	-2.793	.182	2.799
400.000	-2.182	.294	-1.199	2.507	.210	1.655	.288	1.693
440.000	-4.741	3.004	-3.018	6.372	.004	.328	-.052	.332
480.000	-1.397	-1.697	-3.406	4.053	-.005	-.718	.207	.747
520.000	-4.385	-5.608	.602	7.145	.036	.809	-.119	.818
560.000	-.681	.572	-1.076	1.396	-.039	-.388	.012	.390
600.000	1.483	2.200	-3.165	4.173	-.021	-.431	.298	.524
640.000	-.541	3.088	.543	3.182	-.001	-.264	-.088	.222
680.000	.816	3.758	2.662	4.677	.007	-.087	-.155	.177
720.000	-1.015	.950	.489	1.474	.021	.144	.115	.186
760.000	-2.963	-2.381	.266	3.811	.027	.250	.211	.328
800.000	-2.510	-3.319	.894	4.256	.007	.188	-.058	.197
840.000	-.848	.122	1.483	1.713	-.012	-.145	-.098	.175
880.000	-1.027	2.397	.611	2.679	-.026	-.355	-.069	.362
920.000	-1.502	2.467	-.394	2.915	-.019	-.249	.081	.262
960.000	-1.027	.219	-.210	1.071	-.001	.016	.084	.086
1000.000	-.576	-1.238	.522	1.462	.016	.162	-.043	.169
1040.000	-.648	-1.928	1.192	2.358	.021	.204	-.104	.229
1080.000	-.959	-1.513	.269	1.812	.013	.089	-.043	.100
1120.000	-.725	-1.161	-.943	1.662	.010	.013	.060	.062
1160.000	-.433	-.922	-1.364	1.702	.008	-.026	.081	.086
1200.000	-.791	-.253	-.981	1.286	.004	-.063	.013	.064
1240.000	-1.193	.887	-.576	1.594	-.000	-.114	-.054	.126
1280.000	-1.166	1.987	-.486	2.354	-.008	-.206	-.043	.211
1320.000	-.812	1.960	-.730	2.243	-.015	-.256	.031	.258
1360.000	-.604	1.804	-.846	2.078	-.027	-.406	.054	.411
1400.000	-.423	2.040	-1.071	2.343	-.026	-.406	.054	.411
1440.000	-.376	2.065	-1.411	2.529	.005	.264	.033	.266
1480.000	-.382	1.826	-1.693	2.519	.011	.368	.029	.369
1520.000	-.471	1.552	-2.080	2.637	.051	-.122	-.571	.586
1560.000	-.744	.976	-1.834	2.206	-.142	-1.492	-.496	1.579
1600.000	-1.030	.624	-1.851	2.208	.095	.310	-.028	.326

RUN DESCRIPTION: 5TH [illegible]N-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT ANGULAR DISPLACEMENTS (DEG) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	YAW	PITCH	ROLL	RES	YAW	PITCH	ROLL	RES
0.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
40.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
80.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
120.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
160.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
200.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
240.000	1.001	7.948	-.306	8.019	0.000	12.028	0.000	12.028
280.000	5.380	-13.713	-3.385	14.963	0.000	6.289	0.000	6.289
320.000	19.483	-42.242	-17.740	46.793	-.193	16.771	-.032	16.772
360.000	50.447	-58.033	-52.353	73.520	-2.805	23.734	-.928	23.892
400.000	63.087	-45.929	-77.423	84.545	-2.975	20.942	-.864	21.145
440.000	39.018	7.758	-93.817	102.493	-3.749	10.301	-1.004	10.981
480.000	-41.464	45.287	-137.664	127.948	-1.352	2.654	-.799	3.076
520.000	-50.090	-35.492	-104.473	129.519	-2.801	4.529	-.831	5.372
560.000	40.022	-86.179	166.763	162.384	-6.601	4.947	-1.086	8.281
600.000	-37.028	-58.618	-148.076	171.060	-5.197	1.948	-.922	5.611
640.000	-46.530	-29.306	-177.728	170.561	-3.469	-.993	-.765	3.694
680.000	-5.790	15.268	159.967	160.940	-5.291	-2.327	-.574	5.819
720.000	21.450	53.126	170.713	162.272	-5.807	-1.248	-.422	5.959
760.000	-13.228	42.093	122.121	131.289	-3.400	1.347	-.303	3.666
800.000	-15.119	-14.429	92.604	92.522	-2.055	5.311	-.157	5.694
840.000	16.555	-40.949	69.361	85.603	-3.369	5.367	-.204	6.334
880.000	33.702	-17.636	68.228	81.409	-4.607	1.701	-.212	4.912
920.000	34.484	25.450	75.273	77.916	-4.487	-3.151	-.165	5.489
960.000	22.229	51.075	66.006	76.042	-3.132	-4.679	-.192	5.638
1000.000	8.712	46.222	46.423	62.567	-2.842	-3.290	-.143	4.352
1040.000	13.812	23.463	31.430	39.118	-3.917	-.460	-.031	3.944
1080.000	21.619	3.413	11.647	24.452	-4.995	1.747	.048	5.293
1120.000	17.266	-9.908	-7.051	20.584	-4.825	2.391	.150	5.390
1160.000	2.257	-23.269	-17.788	29.020	-3.745	2.321	.290	4.420
1200.000	-10.821	-33.273	-26.466	45.452	-3.008	1.664	.412	3.467
1240.000	-11.547	-32.247	-44.792	58.369	-3.322	.455	.504	3.393
1280.000	-9.091	-14.233	-67.901	70.814	-4.185	-1.854	.603	4.608
1320.000	-17.287	12.495	-88.433	88.587	-4.175	-4.938	.685	6.520
1360.000	-37.162	30.717	-110.423	107.571	-3.480	-9.983	.690	10.578
1400.000	-70.982	41.532	-143.706	128.719	-2.694	-15.849	.624	16.073
1440.000	66.596	145.225	-1.744	152.018	-1.891	-21.280	.494	21.360
1480.000	35.329	167.078	-21.932	174.508	-1.477	-15.946	.494	16.015
1520.000	8.319	-166.782	-25.443	167.256	-4.697	-3.349	1.032	5.835
1560.000	-25.242	-152.343	-13.944	156.252	-9.242	-8.059	1.824	12.295
1600.000	-61.026	-152.694	4.946	154.058	-12.828	-14.599	2.891	19.381

1 DATE: 20-MAY-82

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 3)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

0 SPRING DAMPER FORCES

	SPRING DAMPER NO. 1		SPRING DAMPER NO. 2	
	SEG 1(MS) - SEG 2(CH)		SEG 1(MS) - SEG 2(CH)	
TIME (MSEC)	LENGTH (IN)	FORCE (LB)	LENGTH (IN)	FORCE (LB)
0.000	10.263	0.00	10.131	0.00
40.000	10.263	0.00	10.131	0.00
80.000	10.263	0.00	10.131	0.00
120.000	10.263	0.00	10.131	0.00
160.000	10.263	0.00	10.131	0.00
200.000	10.263	0.00	10.131	0.00
240.000	11.609	0.00	11.668	0.00
280.000	37.376	0.00	37.036	0.00
320.000	27.047	0.00	27.279	0.00
360.000	50.362	1243.44	48.948	1073.75
400.000	61.109	2533.07	57.085	2050.26
440.000	74.072	4088.62	72.126	3855.11
480.000	87.902	5748.24	98.208	6984.98
520.000	81.787	5014.45	78.554	4626.45
560.000	77.923	4550.78	71.091	3730.93
600.000	65.820	3098.36	66.581	3189.72
640.000	65.671	3080.49	73.844	4061.24
680.000	63.106	2772.68	61.831	2619.70
720.000	66.758	3210.90	59.885	2386.22
760.000	56.889	2026.69	51.663	1399.55
800.000	58.052	2166.26	62.282	2673.87
840.000	50.117	1214.03	59.339	2320.68
880.000	48.476	1017.07	53.985	1678.19
920.000	58.163	2179.51	55.527	1863.21
960.000	52.846	1541.58	46.725	806.97
1000.000	52.404	1488.53	47.692	923.06
1040.000	51.443	1373.17	52.163	1459.58
1080.000	46.712	805.39	51.786	1414.28
1120.000	46.439	772.74	50.413	1249.51
1160.000	48.865	1063.86	48.459	1015.10
1200.000	49.427	1131.24	45.161	619.29
1240.000	48.988	1078.61	43.651	438.16
1280.000	47.903	948.39	45.448	653.77
1320.000	44.829	579.43	47.963	955.51
1360.000	29.892	0.00	34.395	0.00
1400.000	27.833	0.00	29.923	0.00
1440.000	39.106	0.00	40.817	98.05
1480.000	34.641	0.00	34.448	0.00
1520.000	49.710	1165.15	47.443	893.14
1560.000	36.502	0.00	40.031	3.75
1600.000	28.706	0.00	27.649	0.00

1 ELAPSED CPU TIME = 13.62 SECONDS

SUB	CALLS	TIME	%
MAIN3D	1	6	.44
INPUT	1	10	.73
CHAIN	2036	12	.88
DINT	41	179	13.14
PDAUX	2453	218	16.01
DAUX	2035	208	15.27
SETUP1	2035	10	.73
CONTCT	2035	74	5.43
	2035	143	10.50
WINDY	4070	118	8.66
SPDAMP	2035	71	5.21
VISPR	2035	21	1.54
EJOINT	2035	17	1.25
SETUP2	2035	10	.73
DAUX11	2035	11	.81
DAUX12	2035	15	1.10
DAUX22	2035	18	1.32
FSMSOL	2035	15	1.10
OUTPUT	419	71	5.21
UPDATE	418	3	.22
DZP	2034	83	6.09
POSTPR	1	49	3.60
0TOTAL		1362	100.00

*EOR

```
1  CSA   NOS/BE L530H       L530H-CMR1 03/15/82
 18.14.45.GB19LMH  FROM    /9L
 18.14.45.IP  00000128 WORDS - FILE INPUT  , DC 04
 18.14.45.GB1,T30,IO30,CM327000,STCSA.    L800764/
 18.14.45.BUTLER
 18.14.45.ACCOUNT TO BE CLOSED AT END OF MONTH
 18.14.45.CALL YOUR OCR
 18.14.46. INTERCOM BATCH JOB - NO DECK
 18.14.46.ATTACH,ATBM,ATBGBAIRFLOWBINARY1982,MR=1.
 18.14.46.AT CY= 001 SN=AFIT
 18.14.47.ATTACH,BPLT,CCPLOT56X,SN=ASD,ID=LIBRARY.
 18.14.47.AT CY= 999 SN=ASD
 18.14.47.ATTACH,AIRFLOW,ATBGBAIRFLOW5THINPUT,CY=4
 18.14.47..
 18.14.47.ATTACH,TAPE10,SMAERO,ID=FDLTR7457,SN=AFF
 18.14.47.DL,MR=1.
 18.14.48.AT CY= 999 SN=AFFDL
 18.14.48.MAP,ON.
 18.14.48.LIBRARY,BPLT.
 18.14.48.LDSET,PRESET=ZERO.
 18.14.48.ATBM,AIRFLOW,PL=12000.
 18.18.31.    STOP  1
 18.18.31.    275600 MAXIMUM EXECUTION FL.
 18.18.31.    13.635 CP SECONDS EXECUTION TIME.
 18.18.31.OP  00018176 WORDS - FILE OUTPUT , DC 40
 18.18.31.MS   18240  WORDS  (   65664 MAX USED)
 18.18.31.CPA      15.259 SEC.       12.435 ADJ.
 18.18.31.IO       11.331 SEC.        3.353 ADJ.
 18.18.31.CM    2235.751 KWS.        10.531 ADJ.
 18.18.31.CRUS                       26.321
 18.18.31.COST                 $      1.73
 18.18.31.PP        8.546 SEC.     DATE 05/27/82
 18.18.31.EJ  END OF JOB, 9L  L800764.
```

1 AFAMRL ARTICULATED TOTAL BODY (ATB-II) MODEL

DEVELOPED BY CALSPAN CORP., P.O. BOX 400, BUFFALO NY 14225
AND BY J & J TECHNOLOGIES INC., ORCHARD PARK NY 14127

FOR THE AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY,
AFSC AERONAUTICAL SYSTEMS DIVISION, WRIGHT-PATTERSON AFB
UNDER CONTRACTS F33615-75C-5002, -78C-0516 AND -80C-0511

AND FOR THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION,
U.S. DEPARTMENT OF TRANSPORTATION, UNDER CONTRACTS
FH-11-7592, HS-053-2-485, HS-6-01300 AND HS-6-01410.

PROGRAM DOCUMENTATION: NHTSA REPORT NOS. DOT-HS-801-507
THROUGH 510 (FORMERLY CALSPAN REPORT NO. ZQ-5180-L-1),
AVAILABLE FROM NTIS (ACCESSION NOS. PB-241692,3,4 AND 5),
APPENDIXES A-J TO THE ABOVE (AVAILABLE FROM CALSPAN),
AND REPORT NOS. AMRL-TR-75-14 AND AFAMRL-TR-80-14.

PROGRAM ATB-II, EXECUTED ON THE CDC CYBER COMPUTER SYSTEM,
AFSC ASD COMPUTER CENTER, WRIGHT-PATTERSON AFB, OHIO 45433

20-MAY-82 IRSIN= 0 IRSOUT= 0 RSTIME = 0.0000 CARDS A

5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

UNITL = IN UNITM = LB UNITT = SEC GRAVITY VECTOR = (0.0000, 0.0000, 386.0880)

NDINT = 6 NSTEPS = 40 DT = .040000 H0 = .000125 HMAX = .004000 HMIN = .000125

0 NPRT ARRAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

1 CRASH VICTIM SINGLE MAN(5%)-SEAT 2 SEGMENTS 1 JOINTS CARD B.1

CARDS B.2

SEGMENT			WEIGHT	PRINCIPAL MOMENTS OF INERTIA (LB - SEC**2- IN)			SEGMENT CONTACT ELLIPSOID SEMIAXES (IN)			CENTER (IN)			PRINCIPAL AXES (DEG)		
I	SYM	PLOT	(LB)	X	Y	Z	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL
1	MS	M	298.800	197.0400	186.1200	50.1650	144.000	6.480	34.460	-5.040	0.000	8.140	0.00	-20.84	0.00
2	CH	C	25.000	25.0000	20.0000	25.0000	38.400	38.400	38.400	0.000	0.000	0.000	0.00	0.00	0.00

CARDS B.3

JOINT					LOCATION(IN) - SEG(JNT)			LOCATION(IN) - SEG(J+1)			PRIN. AXIS(DEG) - SEG(JNT)			PRIN. AXIS(DEG) - SEG(J+1)		
J	SYM	PLOT	JNT	PIN	X	Y	Z	X	Y	Z	YAW	PITCH	ROLL	YAW	PITCH	ROLL
1	NULL	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00

1 JOINT TORQUE CHARACTERISTICS

CARDS B.4

JOINT	FLEXURAL SPRING CHARACTERISTICS: SPRING COEF. (IN LB /DEG**J) LINEAR (J=1)	QUADRATIC (J=2)	CUBIC (J=3)	ENERGY DISSIPATION COEF.	JOINT STOP (DEG)	TORSIONAL SPRING CHARACTERISTICS: SPRING COEF. (IN LB /DEG**J) LINEAR (J=1)	QUADRATIC (J=2)	CUBIC (J=3)	ENERGY DISSIPATION COEF.	JOINT STOP (DEG)
1 NULL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CARDS B.5

JOINT VISCOUS CHARACTERISTICS AND LOCK-UNLOCK CONDITIONS

JOINT	VISCOUS COEFFICIENT (IN LB SEC/DEG)	COULOMB FRICTION COEF. (IN LB)	FULL FRICTION ANGULAR VELOCITY (DEG/ SEC)	MAX TORQUE FOR A LOCKED JOINT (IN LB)	MIN TORQUE FOR UNLOCKED JOINT (IN LB)	MIN. ANG. VELOCITY FOR UNLOCKED JOINT (RAD/ SEC)	IMPULSE RESTITUTION COEFFICIENT
1 NULL	0.000	0.00	0.00	0.00	0.00	0.00	0.000

SEGMENT INTEGRATION CONVERGENCE TEST INPUT

SEGMENT		ANGULAR VELOCITIES (RAD/ SEC)			LINEAR VELOCITIES (IN / SEC)			ANGULAR ACCELERATIONS (RAD/ SEC**2)			LINEAR ACCELERATIONS (IN / SEC**2)		
NO.	SYM	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR	MAG. TEST	ABS. ERROR	REL. ERROR
1	MS	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000
2	CH	0.000	0.000	0.0000	0.000	0.000	0.0000	.001	.100	.1000	.001	.100	.1000

1 VEHICLE DECELERATION INPUTS CARDS C

AIRFRAME

YAW	PITCH	ROLL	VIPS	VTIME	X0(X)	X0(Y)	X0(Z)	NATAB	AT0	ADT	MSEG
0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0	0.000000	0.000000	0

0 PASSENGER COMPARTMENT DISPLACEMENT HISTORY
ANALYTICAL HALF-SINE WAVE DECELERATION
V0= 0.000 IN / SEC, OBLIQUE ANGLES = 0.00 0.00 0.00 DEGREES, TIME DURATION = 1.000 SEC

1	NPL	NBLT	NBAG	NELP	NQ	NSD	NHRNSS	NWINDF	NJNTF	NFORCE	CARD D.1
	1	0	0	0	0	2	0	1	0	4	

0 PLANE INPUTS — CARDS D.2

0 PLANE NO. 1 EJEC PLANE

	X	Y	Z
POINT 1	30.0000	30.0000	-100.0000
POINT 2	-30.0000	30.0000	-100.0000
POINT 3	-30.0000	-30.0000	-100.0000

0 BODY SEGMENT SYMMETRY INPUT — CARD D.7

SEG NO.	1	2
0 NSYM(J)	0	0

0 SPRING DAMPERS FUNCTION INPUT — CARDS D.8

COORDINATES OF ATTACHMENT POINTS (IN)

	SEGMENT		SEGMENT M			SEGMENT N			SPRING FORCE FUNCTION			DAMPING FORCE FUNCTION	
NO.	M	N	X	Y	Z	X	Y	Z	D0	A1	A2	B1	B2
1	1	2	-11.64	6.12	-4.34	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000
2	1	2	-11.64	-6.12	-4.34	176.47	0.00	0.00	40.00	-120.000	0.000	0.000	0.000

0 FORCE FUNCTIONS INPUT — CARDS D.9

NO.	SEG	FCN1	FCN2	X	Y	Z	YAW	PITCH	ROLL
1	1	1	0	-9.468	0.000	8.488	0.000	40.750	0.000
2	1	-2	3	-2.530	0.000	16.540	0.000	77.600	0.000
3	1	4	0	-10.440	0.000	-8.000	0.000	-30.000	0.000
4	2	5	0	0.000	0.000	0.000	0.000	150.000	0.000

1FUNCTION NO. 1 SUSTAINER ROCKET NTI(1) = 1 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 9 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.214000	3425.0000
.243000	3680.0000
.354000	3400.0000
.494000	3150.0000
.605000	1000.0000
.653000	0.0000
1.600000	0.0000

0FUNCTION NO. 2 STAPAC ROCKET NTI(2) = 25 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 12 TABULAR POINTS

D	F(D)
0.000000	0.0000
.198000	0.0000
.199000	23.4000
.203000	890.6000
.204000	703.1000
.428000	723.8000
.698000	492.2000
.742000	515.6000
.755000	445.3000
.779000	82.0000
.800000	0.0000
1.600000	0.0000

1FUNCTION NO. 3 STAPAC PITCH VS RATE NTI(3) = 55 CARDS E

D0	D1	D2	D3	D4
-6.2830	-6.2830	0000	0.0000	0.0000

FIRST PART OF FUNCTION - 4 TABULAR POINTS

D	F(D)
-6.283000	-.7854
-1.571000	-.7854
1.571000	.7854
6.283000	.7854

0FUNCTION NO. 4 DROGUE GUN ON SEAT NTI(4) = 69 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	1756.0000
.216000	1756.0000
.217000	0.0000
1.600000	0.0000

1FUNCTION NO. 5 DROGUE GUN ON CHUTE NTI(5) = 87 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 6 TABULAR POINTS

D	F(D)
0.000000	0.0000
.211000	0.0000
.212000	2200.0000
.216000	2200.0000
.217000	0.0000
1.600000	0.0000

0FUNCTION NO. 6 CHUTE CA FUNCTION NTI(6) = 105 CARDS E

D0	D1	D2	D3	D4
0.0000	-1.6000	0.0000	0.0000	0.0000

FIRST PART OF FUNCTION - 8 TABULAR POINTS

D	F(D)
0.000000	0.0000
.213000	0.0000
.355000	.0300
.478000	.4600
.500000	.4600
1.300000	.4600
1.316000	0.0000
1.600000	0.0000

1 WIND FORCE FUNCTION NO. 41 WIND FORCE ON CHUTE NTI(41) = 127

D0	D1	D2	D3	D4
0.0000	0.0000	0.0000	0.0000	0.0000

0 WIND FORCE TABLES FOR 2 TIME POINTS.

T	FX(T)	FY(T)	FZ(T)
0.000000	0.	0.	0.
.001000	-10.0000	0.	0.

1 ALLOWED CONTACTS AND ASSOCIATED FUNCTIONS

SEGMENT-ELLIPSOID	SEGMENT-PLANE	WIND FORCE FUNCTION
0 2 - -2	3 - 1	6
CH	VEH - EJEC PLANE	CHUTE CA FUNCTION

1 SUBROUTINE INITAL INPUT CARD G.1

ZPLT(X)	ZPLT(Y)	ZPLT(Z)	I1	J1	I2	J2	I3	SPLT(1)	SPLT(2)	SPLT(3)
1.	1.	1.	0	0	0	0	1	10.00	6.00	1.00

0 INITIAL POSITIONS (INERTIAL REFERENCE) CARDS G.2

SEGMENT		LINEAR POSITION (IN)			LINEAR VELOCITY (IN / SEC)		
NO.	SEG	X	Y	Z	X	Y	Z
1	MS	3.15871	0.00000	-9.03791	-122.40370	0.00000	-634.36440
2	CH	-178.01766	0.00000	34.84606	-122.40370	0.00000	-634.36440

0 INITIAL ANGULAR ROTATION AND VELOCITY CARDS G.3

SEGMENT		ANGULAR ROTATION (DEG)			ANGULAR VELOCITY (DEG/ SEC)			IYPR			
NO.	SEG	YAW	PITCH	ROLL	X	Y	Z				
1	MS	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0
2	CH	0.00000	12.50000	0.00000	0.00000	0.00000	0.00000	1	2	3	0

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1    TIME        MACH     ALPHA     BETA          CX          CY         CZ           CL        CM          CN

 CARD H.1  3      1  1  2
 CARD H.2  3      1  1  2
 CARD H.3  3      1  1  2
 CARD H.4  2      1  2
 CARD H.5  2      1  2
 CARD H.6  2      1  2
 CARD H.7  0      0
   214.00        .9005     9.85     0.00      -7761.01      0.00    1927.27       0.00 -47400.73      0.00
   240.00        .8829     4.83     0.00      -7774.04      0.00    2392.08       0.00 -49746.50      0.00
   280.00        .8626   -18.06     0.00      -7509.22      0.00    2907.69       0.00 -28575.90      0.00
0 DINT CONV. TEST   288.000   CH    ANG ACC    4823.       9279.       .2279      .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .288000 FOR H =    .004000
   320.00        .8542   -49.70     0.00      -6205.01      0.00    4168.03       0.00    331.00      0.00
   360.00        .8539   -74.91     0.00      -3381.72      0.00    3652.98       0.00  10208.74      0.00
   400.00        .8400   -77.84     0.00      -2968.79      0.00    3535.17       0.00   6718.45      0.00
   440.00        .8225   -51.88     0.00      -5457.79      0.00    3748.15       0.00   2392.86      0.00
0 DINT CONV. TEST   448.000   CH    ANG ACC    .7409E+05   .5642E+05   .6236E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .448000 FOR H =    .004000
0 DINT CONV. TEST   464.000   CH    ANG ACC    .1289E+08   .1336E+07   .8028E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .464000 FOR H =    .004000
0 DINT CONV. TEST   476.000   CH    ANG ACC    .1656E+05   6475.       .3671      .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .476000 FOR H =    .004000
   480.00        .7861    11.39     0.00      -5489.85      0.00    1150.68       0.00 -32256.84      0.00
0 DINT CONV. TEST   488.000   CH    ANG ACC    .9988E+07   .4864E+07   .4869      .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .488000 FOR H =    .004000
0 DINT CONV. TEST   492.000   CH    ANG ACC    .3716E+06   .5298E+05   .1421      .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .492000 FOR H =    .004000
0 DINT CONV. TEST   504.000   CH    ANG ACC    .7976E+07   .6895E+06   .8626E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .504000 FOR H =    .004000
0 DINT CONV. TEST   508.000   CH    ANG ACC    .1675E+07   .3025E+05   .1793E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .508000 FOR H =    .004000
   520.00        .7066    66.12     0.00      -1310.10      0.00   -2937.86       0.00  14036.18      0.00
0 DINT CONV. TEST   520.000   CH    ANG ACC    .2372E+07   .2127E+06   .8910E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .520000 FOR H =    .004000
   560.00        .6492    77.54     0.00       -159.50      0.00   -2666.77       0.00  23120.86      0.00
   600.00        .6038    60.98     0.00      -1238.03      0.00   -1961.81       0.00   7959.39      0.00
   640.00        .5640    25.96     0.00      -1774.21      0.00    -300.33       0.00 -10956.57      0.00
0 DINT CONV. TEST   668.000   CH    ANG ACC    129.5       6.982       .3609E-01   .1000E-05   .1000E-01   .1000E-01
0 TEST FAILED AT TIME =    .668000 FOR H =    .004000
   680.00        .5342   -10.01     0.00      -2347.76      0.00     897.22       0.00 -13130.68      0.00
   720.00        .5120   -28.32     0.00      -2147.47      0.00    1023.33       0.00  -6036.40      0.00
   760.00        .4901   -24.55     0.00      -1980.50      0.00     911.29       0.00  -6862.85      0.00
   800.00        .4690    -7.11     0.00      -1806.30      0.00     662.52       0.00 -11015.99      0.00
   840.00        .4465    15.31     0.00      -1427.29      0.00     175.30       0.00  -8978.01      0.00
   880.00        .4253    34.29     0.00       -747.26      0.00    -436.07       0.00  -3847.91      0.00
   920.00        .4061    45.59     0.00       -439.67      0.00    -653.44       0.00   -618.01      0.00
   960.00        .3891    48.04     0.00       -347.07      0.00    -635.44       0.00   -154.17      0.00
  1000.00        .3734    42.32     0.00       -440.66      0.00    -488.01       0.00  -1200.37      0.00
  1040.00        .3587    30.36     0.00       -620.71      0.00    -225.26       0.00  -3494.29      0.00
  1080.00        .3449    14.88     0.00       -858.20      0.00     112.63       0.00  -5404.19      0.00
  1120.00        .3321     -.92     0.00       -975.27      0.00     367.48       0.00  -6593.72      0.00
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1160.00	.3214	-14.04	0.00	-846.40	0.00	348.16	0.00	-4293.77	0.00
1200.00	.3120	-21.70	0.00	-805.16	0.00	352.78	0.00	-3044.00	0.00
1240.00	.3032	-22.95	0.00	-759.56	0.00	340.10	0.00	-2766.83	0.00
1280.00	.2950	-18.31	0.00	-718.31	0.00	303.70	0.00	-3086.49	0.00
1320.00	.2871	-9.17	0.00	-677.71	0.00	255.99	0.00	-3888.79	0.00
1360.00	.2826	1.20	0.00	-709.31	0.00	258.65	0.00	-4826.55	0.00
1400.00	.2791	9.53	0.00	-624.23	0.00	148.55	0.00	-4117.13	0.00
1446.00	.2761	15.88	0.00	-540.09	0.00	60.49	0.00	-3397.81	0.00
1480.00	.2734	20.56	0.00	-483.64	0.00	4.98	0.00	-3045.11	6.00
1520.00	.2730	23.78	0.00	-442.80	0.00	-40.05	0.00	-2782.59	0.00
1560.00	.2753	26.62	0.00	-414.30	0.00	-80.85	0.00	-2527.59	0.00
1600.00	.2733	28.45	0.00	-384.87	0.00	-104.83	0.00	-2262.43	0.00

1 DATE: 20-MAY-82 PAGE: 21.01

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT LINEAR ACCELERATIONS (G"S) IN LOCAL REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-5.04, 0.00, 8.14) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
40.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
80.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
120.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
160.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000	-.216	0.000	.976	1.000
200.000	-.044	0.000	.191	.196	-.023	0.000	.218	.220	-.216	0.000	.976	1.000
240.000	-16.047	0.000	-10.039	18.928	-18.619	0.000	-14.773	23.768	-8.591	0.000	-.373	8.599
280.000	-15.613	0.000	-7.991	17.539	-14.105	0.000	-12.289	18.707	-20.349	0.000	-.240	20.350
320.000	-12.821	0.000	-2.538	13.070	-8.639	0.000	-4.028	9.532	-29.623	0.000	-6.347	30.295
360.000	-2.859	0.000	6.922	7.489	1.991	0.000	11.057	11.235	36.838	0.000	-21.460	42.633
400.000	-3.264	0.000	14.014	14.389	1.145	0.000	19.131	19.165	-46.072	0.000	-66.532	80.926
440.000	-25.702	0.000	21.566	33.551	-9.900	0.000	25.724	27.563	-24.152	0.000	-32.966	40.866
480.000	-50.599	0.000	-22.122	55.223	-32.765	0.000	-40.481	52.080	.524	0.000	65.811	65.813
520.000	-6.592	0.000	-54.451	54.849	-10.896	0.000	-68.803	69.661	-32.977	0.000	33.978	47.350
560.000	3.362	0.000	-38.181	38.329	-.415	0.000	-43.313	43.315	-80.365	0.000	-18.393	82.443
600.000	-12.169	0.000	-31.988	34.224	-12.658	0.000	-38.364	40.398	-15.230	0.000	-35.083	38.246
640.000	-25.170	0.000	-11.319	27.598	-19.842	0.000	-15.756	25.337	-22.900	0.000	-29.314	37.199
680.000	-26.774	0.000	5.518	27.337	-20.431	0.000	7.003	21.597	-23.510	0.000	-11.279	26.076
720.000	-21.350	0.000	9.459	23.351	-17.119	0.000	14.686	22.555	-30.454	0.000	6.003	31.040
760.000	-21.678	0.000	6.373	22.596	-18.892	0.000	8.920	20.892	-26.897	0.000	12.407	29.621
800.000	-20.450	0.000	1.902	20.538	-17.776	0.000	1.617	17.849	-19.131	0.000	10.718	21.929
840.000	-17.420	0.000	-4.431	17.975	-16.220	0.000	-6.614	17.517	-15.338	0.000	6.571	16.687
880.000	-12.193	0.000	-8.808	15.042	-12.616	0.000	-11.261	16.911	-13.712	0.000	1.805	13.831
920.000	-9.008	0.000	-9.996	13.456	-10.336	0.000	-12.090	15.906	-14.753	0.000	-2.407	14.948
960.000	-8.065	0.000	-9.249	12.272	-9.412	0.000	-11.045	14.511	-13.876	0.000	-4.998	14.749
1000.000	-8.847	0.000	-7.452	11.567	-9.541	0.000	-9.047	13.148	-11.764	0.000	-5.765	13.101
1040.000	-10.217	0.000	-4.662	11.230	-10.020	0.000	-6.000	11.679	-10.300	0.000	-5.104	11.496
1080.000	-11.400	0.000	-1.370	11.482	-10.444	0.000	-2.169	10.667	-9.460	0.000	-3.458	10.072
1120.000	-11.277	0.000	1.515	11.378	-10.005	0.000	1.409	10.103	-10.494	0.000	-1.235	10.567
1160.000	-9.756	0.000	3.019	10.213	-8.407	0.000	3.869	9.255	-10.565	0.000	.954	10.608
1200.000	-8.688	0.000	3.580	9.397	-7.538	0.000	4.916	8.999	-10.769	0.000	2.561	11.069
1240.000	-7.994	0.000	3.399	8.687	-6.999	0.000	4.679	8.419	-10.463	0.000	3.351	10.987
1280.000	-7.740	0.000	2.720	8.204	-6.788	0.000	3.577	7.673	-8.915	0.000	3.465	9.565
1320.000	-6.879	0.000	1.613	7.066	-6.127	0.000	1.714	6.362	53.502	0.000	.855	53.509
1360.000	-2.715	0.000	.947	2.875	-2.781	0.000	.188	2.788	-.140	0.000	.990	1.000
1400.000	-2.455	0.000	.667	2.544	-2.600	0.000	.087	2.601	-.138	0.000	.991	1.000
1440.000	-2.187	0.000	.451	2.233	-2.358	0.000	.012	2.358	-.135	0.000	.991	1.000
1480.000	-[illegible].013	0.000	.309	2.036	-2.209	0.000	-.052	2.209	-.132	0.000	.991	1.000
1520.000	3.244	0.000	3.599	4.845	3.465	0.000	3.838	5.170	-73.350	0.000	-4.630	73.496
1560.000	-1.775	0.000	.071	1.777	-1.962	0.000	-.210	1.973	.000	0.000	1.000	1.000
1600.000	-1.677	0.000	.015	1.677	-1.856	0.000	-.228	1.870	.152	0.000	.988	1.000

1 DATE: 20-MAY-82 PAGE: 22.01

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT LINEAR VELOCITIES (IN / SEC) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-5.04, 0.00, 8.14) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	-122.404	0.000	-634.364	646.066	-122.404	0.000	-634.364	646.066	-122.404	0.000	-634.364	646.066
40.000	-122.404	0.000	-618.921	630.909	-122.404	0.000	-618.921	630.909	-122.404	0.000	-618.921	630.909
80.000	-122.404	0.000	-603.477	615.766	-122.404	0.000	-603.477	615.766	-122.404	0.000	-603.477	615.766
120.000	-122.404	0.000	-588.034	600.638	-122.404	0.000	-588.034	600.638	-122.404	0.000	-588.034	600.638
160.000	-122.404	0.000	-572.590	585.527	-122.404	0.000	-572.590	585.527	-122.404	0.000	-572.590	585.527
200.000	-122.404	0.000	-557.354	570.636	-122.397	0.000	-557.348	570.629	-122.404	0.000	-557.147	570.434
240.000	-298.528	0.000	-639.912	706.120	-337.950	0.000	-678.872	758.339	-339.612	0.000	-593.954	684.191
280.000	-530.595	0.000	-787.314	949.418	-577.877	0.000	-896.129	1066.297	-563.256	0.000	-567.447	799.533
320.000	-700.204	0.000	-971.221	1197.311	-685.139	0.000	-1095.320	1291.952	-956.056	0.000	-555.254	1105.599
360.000	-770.113	0.000	-1070.943	1319.088	-733.008	0.000	-1130.788	1347.583	-1199.751	0.000	-651.239	1365.106
400.000	-958.498	0.000	-1027.329	1405.035	-980.635	0.000	-996.177	1397.860	-1316.531	0.000	-1541.900	2027.489
440.000	-1283.463	0.000	-1054.803	1661.291	-1316.396	0.000	-865.103	1575.215	-2310.216	0.000	-1973.375	3038.306
480.000	-2004.823	0.000	-1152.983	2312.722	-1753.399	0.000	-978.715	2008.056	-2379.102	0.000	-1604.525	2869.604
520.000	-2867.632	0.000	-1292.890	3145.612	-2738.007	0.000	-1345.594	3050.788	-2225.470	0.000	-853.933	2383.677
560.000	-3571.140	0.000	-1384.015	3829.953	-3588.307	0.000	-1372.456	3841.820	-3382.213	0.000	-701.563	3454.208
600.000	-4126.887	0.000	-1414.623	4362.609	-4234.981	0.000	-1380.040	4454.164	-4121.321	0.000	-1040.666	4250.690
640.000	-4580.473	0.000	-1382.202	4784.476	-4733.797	0.000	-1427.985	4944.490	-4508.264	0.000	-1471.832	4742.440
680.000	-5006.420	0.000	-1274.481	5166.096	-5082.265	0.000	-1372.168	5264.244	-4942.783	0.000	1681.286	5220.903
720.000	-5394.006	0.000	-1214.331	5529.006	-5402.731	0.000	-1239.138	5543.011	-5351.877	0.000	-1610.878	5589.053
760.000	-5751.804	0.000	-1201.203	5875.895	-5732.245	0.000	-1155.566	5847.561	-5777.421	0.000	-1369.590	5937.539
800.000	-6082.411	0.000	-1168.715	6193.676	-6022.078	0.000	-1099.058	6121.548	-6095.339	0.000	-1134.531	6200.025
840.000	-6381.138	0.000	-1109.714	6476.912	-6298.903	0.000	-1068.946	6388.961	-6336.038	0.000	-964.752	6409.065
880.000	-6629.669	0.000	-1061.071	6714.044	-6564.890	0.000	-1052.881	6648.784	-6545.709	0.000	-869.458	6603.201
920.000	-6846.732	0.000	-1026.492	6923.252	-6818.497	0.000	-1028.503	6895.631	-6762.362	0.000	-840.656	6814.414
960.000	-7041.997	0.000	-994.752	7111.910	-7050.570	0.000	-993.797	7120.265	-6995.135	0.000	-857.294	7047.472
1000.000	-7222.136	0.000	-958.689	7285.488	-7261.426	0.000	-958.380	7324.398	-7205.537	0.000	-899.015	7261.404
1040.000	-7391.358	0.000	-914.440	7447.709	-7449.963	0.000	-926.516	7507.355	-7391.175	0.000	-942.983	7451.686
1080.000	-7558.380	0.000	-860.544	7607.210	-7618.718	0.000	-891.557	7670.706	-7552.950	0.000	-972.422	7615.291
1120.000	-7727.771	0.000	-804.914	7769.577	-7773.799	0.000	-847.969	7819.911	-7710.079	0.000	-972.032	7771.111
1160.000	-7886.759	0.000	-761.920	7923.477	-7911.902	0.000	-799.628	7952.208	-7871.567	0.000	-936.956	7927.134
1200.000	-8034.909	0.000	-730.337	8068.033	-8043.401	0.000	-747.858	8078.093	-8025.556	0.000	-876.340	8073.259
1240.000	-8171.937	0.000	-705.360	8202.322	-8169.067	0.000	-699.034	8198.921	-8181.003	0.000	-800.005	8220.026
1280.000	-8300.124	0.000	-682.154	8328.108	-8285.869	0.000	-656.306	8311.821	-8319.514	0.000	-722.728	8350.848
1320.000	-8419.967	0.000	-656.773	8445.543	-8392.594	0.000	-621.653	8415.586	-8236.167	0.000	-698.746	8264.915
1360.000	-8472.977	0.000	-635.547	8496.779	-8443.995	0.000	-609.686	8465.977	-8052.778	0.000	-700.566	8083.194
1400.000	-8508.357	0.000	-613.238	8530.428	-8483.680	0.000	-596.856	8504.649	-8052.778	0.000	-685.123	8081.870
1440.000	-8538.216	0.000	-591.852	8558.705	-8518.732	0.000	-581.737	8538.572	-8052.778	0.000	-669.679	8080.576
1480.000	-8564.272	0.000	-571.722	8583.334	-8550.156	0.000	-565.734	8568.852	-8052.778	0.000	-654.236	8079.310
1520.000	-8562.886	0.000	-555.679	8580.897	-8552.951	0.000	-552.058	8570.749	-8350.876	0.000	-606.417	8372.865
1560.000	-8527.350	0.000	-543.291	8544.640	-8516.687	0.000	-540.567	8535.821	-9043.566	0.000	-531.401	9059.165
1600.000	-8548.127	0.000	-526.284	8564.312	-8543.665	0.000	-525.016	8559.781	-9047.963	0.000	-526.278	9063.255

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT LINEAR DISPLACEMENTS (IN) IN VEHICLE REFERENCE

TIME	POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 1 - MS				POINT (-5.04, 0.00, 8.14) ON SEGMENT NO. 1 - MS				POINT (0.00, 0.00, 0.00) ON SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES	X	Y	Z	RES
0.000	3.159	0.000	-9.038	9.574	-.000	0.000	-.000	.000	-178.018	0.000	34.846	181.396
40.000	-1.737	0.000	-34.104	34.148	-4.896	0.000	-25.066	25.539	-182.914	0.000	9.780	183.175
80.000	-6.634	0.000	-58.552	58.926	-9.792	0.000	-49.514	50.473	-187.810	0.000	-14.668	188.382
120.000	-11.530	0.000	-82.382	83.185	-14.688	0.000	-73.344	74.800	-192.706	0.000	-38.498	196.514
160.000	-16.426	0.000	-105.594	106.864	-19.585	0.000	-96.556	98.523	-197.602	0.000	-61.710	207.014
200.000	-21.322	0.000	-128.189	129.950	-24.481	0.000	-119.151	121.640	-202.498	0.000	-84.305	219.347
240.000	-28.500	0.000	-151.677	154.331	-32.367	0.000	-142.918	146.538	-212.438	0.000	-107.726	238.190
280.000	-45.373	0.000	-179.988	185.619	-52.222	0.000	-173.298	180.996	-229.888	0.000	-130.983	264.585
320.000	-70.292	0.000	-215.154	226.345	-79.585	0.000	-212.851	227.243	-259.768	0.000	-153.795	301.882
360.000	-99.727	0.000	-256.495	275.200	-109.126	0.000	-258.315	280.419	-306.128	0.000	-176.737	353.483
400.000	-133.999	0.000	-298.419	327.123	-143.265	0.000	-300.825	333.198	-350.937	0.000	-220.517	414.469
440.000	-177.872	0.000	-339.749	383.494	-187.271	0.000	-337.923	386.345	-425.785	0.000	-291.958	516.268
480.000	-242.531	0.000	-384.076	454.242	-244.829	0.000	-374.782	447.663	-520.664	0.000	-366.898	636.950
520.000	-339.926	0.000	-432.795	550.329	-333.401	0.000	-425.790	540.789	-610.575	0.000	-414.930	738.220
560.000	-469.571	0.000	-486.439	676.106	-461.748	0.000	-480.919	666.704	-720.042	0.000	-443.808	845.828
600.000	-623.688	0.000	-542.758	826.785	-617.718	0.000	-535.273	817.369	-873.439	0.000	-477.519	995.449
640.000	-798.217	0.000	-598.975	997.958	-797.513	0.000	-589.427	991.691	-1045.508	0.000	-528.275	1171.393
680.000	-989.948	0.000	-652.096	1185.422	-994.927	0.000	-643.918	1185.120	-1234.801	0.000	-592.225	1369.476
720.000	-1198.139	0.000	-701.698	1388.494	-1205.450	0.000	-695.516	1391.708	-1440.519	0.000	-658.960	1584.084
760.000	-1421.063	0.000	-749.930	1606.803	-1427.945	0.000	-743.274	1609.809	-1663.324	0.000	-718.781	1811.986
800.000	-1657.864	0.000	-797.449	1839.685	-1662.398	0.000	-789.016	1840.139	-1901.145	0.000	-768.687	2050.666
840.000	-1907.285	0.000	-843.044	2085.296	-1908.208	0.000	-833.515	2082.307	-2149.929	0.000	-810.430	2297.605
880.000	-2167.643	0.000	-886.392	2341.873	-2165.387	0.000	-877.088	2336.275	-2407.619	0.000	-846.867	2552.217
920.000	-2437.249	0.000	-928.119	2607.986	-2433.216	0.000	-919.436	2601.135	-2673.698	0.000	-880.831	2815.060
960.000	-2715.086	0.000	-968.549	2882.669	-2710.710	0.000	-960.034	2875.694	-2948.858	0.000	-914.722	3067.472
1000.000	-3000.410	0.000	-1007.641	3165.091	-2996.934	0.000	-998.720	3158.964	-3232.969	0.000	-949.803	3369.601
1040.000	-3292.708	0.000	-1045.131	3454.595	-3291.178	0.000	-1035.680	3450.288	-3524.981	0.000	-986.668	3660.465
1080.000	-3591.696	0.000	-1080.657	3750.747	-3592.757	0.000	-1071.142	3749.033	-3823.927	0.000	-1025.049	3958.932
1120.000	-3897.416	0.000	-1113.953	4053.485	-3901.041	0.000	-1105.092	4054.547	-4129.160	0.000	-1064.058	4264.057
1160.000	-4209.750	0.000	-1145.242	4362.748	-4215.305	0.000	-1137.445	4366.071	-4440.816	0.000	-1102.339	4575.587
1200.000	-4528.219	0.000	-1175.055	4678.197	-4534.786	0.000	-1168.088	4682.810	-4758.759	0.000	-1138.677	4893.095
1240.000	-4852.391	0.000	-1203.756	4999.473	-4859.132	0.000	-1196.957	5004.386	-5082.907	0.000	-1172.231	5216.328
1280.000	-5181.858	0.000	-1231.507	5326.186	-5188.048	0.000	-1224.204	5330.527	-5412.996	0.000	-1202.671	5544.992
1320.000	-5516.299	0.000	-1258.295	5657.991	-5521.262	0.000	-1250.108	5661.017	-5747.321	0.000	-1230.300	5877.529
1360.000	-5854.370	0.000	-1284.133	5993.550	-5857.785	0.000	-1275.189	5994.978	-6070.467	0.000	-1258.479	6199.544
1400.000	-6194.016	0.000	-1309.108	6330.845	-6196.127	0.000	-1299.770	6336.987	-6392.579	0.000	-1286.193	6520.687
1440.000	-6534.964	0.000	-1333.205	6669.572	-6536.064	0.000	-1323.694	6668.755	-6714.690	0.000	-1313.289	6841.914
1450.000	-6877.024	0.000	-1356.473	7009.527	-6877.382	0.000	-1346.905	7008.034	-7036.801	0.000	-1339.767	7163.207
1520.000	-7219.905	0.000	-1378.990	7350.418	-7219.769	0.000	-1369.417	7348.494	-7360.907	0.000	-1365.285	7486.451
1560.000	-7561.267	0.000	-1400.985	7689.962	-7560.702	0.000	-1391.427	7687.671	-7714.124	0.000	-1387.810	7837.967
1600.000	-7902.786	0.000	-1422.386	8029.770	-7901.956	0.000	-1412.848	8027.269	-8075.889	0.000	-1408.810	8197.849

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT ANGULAR ACCELERATIONS (REV/ SEC**2) IN LOCAL REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.00							
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	0.000	.220	0.000	.220	0.000	0.000	0.000	0.000
240.000	0.000	-34.165	0.000	34.165	0.000	-10.318	0.000	10.318
280.000	0.000	-16.036	0.000	16.036	0.000	-9.429	0.000	9.429
320.000	0.000	8.701	0.000	8.701	0.000	-55.797	0.000	55.797
360.000	0.000	39.986	0.000	39.986	0.000	-126.718	0.000	126.718
400.000	0.000	43.276	0.000	43.276	0.000	-25.656	0.000	25.656
440.000	0.000	82.798	0.000	82.798	0.000	951.332	0.000	951.832
480.000	0.000	-24.101	0.000	24.101	0.000	-719.868	0.000	719.868
520.000	0.000	-89.954	0.000	89.954	0.000	-125.249	0.000	125.249
560.000	0.000	-40.889	0.000	40.889	0.000	-43.918	0.000	43.918
600.000	0.000	-34.418	0.000	34.418	0.000	7.865	0.000	7.865
640.000	0.000	-1.856	0.000	1.856	0.000	6.247	0.000	6.247
680.000	0.000	32.298	0.000	32.298	0.000	1.957	0.000	1.957
720.000	0.000	43.146	0.000	43.140	0.000	1.726	0.000	1.726
760.000	0.000	23.848	0.000	23.848	0.000	1.295	0.000	1.295
800.000	0.000	8.971	0.000	8.971	0.000	2.293	0.000	2.293
840.000	0.000	-6.454	0.000	6.454	0.000	1.633	0.000	1.633
880.000	0.000	-14.158	0.000	14.158	0.000	1.381	0.000	1.381
920.000	0.000	-15.855	0.000	15.855	0.000	.037	0.000	.037
960.000	0.000	-14.405	0.000	14.405	0.000	-.298	0.000	.298
1000.000	0.000	-10.837	0.000	10.837	0.000	-.753	0.000	.753
1040.000	0.000	-6.058	0.000	6.058	0.000	-1.125	0.000	1.125
1080.000	0.000	-.350	0.000	.350	0.000	-1.315	0.000	1.315
1120.000	0.000	4.422	0.000	4.422	0.000	-1.034	0.000	1.034
1160.000	0.000	9.594	0.000	9.594	0.000	-.449	0.000	.449
1200.000	0.000	11.297	0.000	11.297	0.000	.177	0.000	.177
1240.000	0.000	10.402	0.000	10.402	0.000	.531	0.000	.531
1280.000	0.000	8.081	0.000	8.081	0.000	.495	0.000	.495
1320.000	0.000	3.447	0.000	3.447	0.000	4.705	0.000	4.705
1360.000	0.000	-4.127	0.000	4.127	0.000	0.000	0.000	0.000
1400.000	0.000	-3.521	0.000	3.521	0.000	0.000	0.000	0.000
1440.000	0.000	-2.906	0.000	2.906	0.000	0.000	0.000	0.000
1480.000	0.000	-2.604	0.000	2.604	0.000	0.000	0.000	0.000
1520.000	0.000	2.081	0.000	2.081	0.000	197.588	0.000	197.588
1560.000	0.000	-2.161	0.000	2.161	0.000	0.000	0.000	0.000
1600.000	0.000	-1.935	0.000	1.935	0.000	0.000	0.000	0.000

1 DATE: 20-MAY-82

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT ANGULAR VELOCITIES (REV/ SEC) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	X	Y	Z	RES	X	Y	Z	RES
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200.000	0.000	.000	0.000	.000	0.000	0.000	0.000	0.000
240.000	0.000	-.921	0.000	.921	0.000	-.144	0.000	.144
280.000	0.000	-1.972	0.000	1.972	0.000	-.651	0.000	.651
320.000	0.000	-2.078	0.000	2.078	0.000	.228	0.000	.228
360.000	0.000	-1.171	0.000	1.171	0.000	-2.784	0.000	2.784
400.000	0.000	.635	0.000	.635	0.000	2.012	0.000	2.012
440.000	0.000	3.201	0.000	3.201	0.000	.724	0.000	.724
480.000	0.000	5.085	0.000	5.085	0.000	-.994	0.000	.994
520.000	0.000	2.326	0.000	2.326	0.000	.986	0.000	.986
560.000	0.000	-.344	0.000	.344	0.000	.366	0.000	.366
600.000	0.000	-1.887	0.000	1.887	0.000	.251	0.000	.251
640.000	0.000	-2.660	0.000	2.660	0.000	.084	0.000	.084
680.000	0.000	-2.056	0.000	2.056	0.000	-.150	0.000	.150
720.000	0.000	-.437	0.000	.437	0.000	-.233	0.000	.233
760.000	0.000	.825	0.000	.825	0.000	-.146	0.000	.146
800.000	0.000	1.532	0.000	1.532	0.000	-.053	0.000	.053
840.000	0.000	1.526	0.000	1.526	0.000	.015	0.000	.015
880.000	0.000	1.085	0.000	1.085	0.000	.079	0.000	.079
920.000	0.000	.471	0.000	.471	0.000	.109	0.000	.109
960.000	0.000	-.143	0.000	.143	0.000	.104	0.000	.104
1000.000	0.000	-.653	0.000	.653	0.000	.077	0.000	.077
1040.000	0.000	-.995	0.000	.995	0.000	.037	0.000	.037
1080.000	0.000	-1.128	0.000	1.128	0.000	-.011	0.000	.011
1120.000	0.000	-1.048	0.000	1.048	0.000	-.055	0.000	.055
1160.000	0.000	-.753	0.000	.753	0.000	-.082	0.000	.082
1200.000	0.000	-.324	0.000	.324	0.000	-.084	0.000	.084
1240.000	0.000	.115	0.000	.115	0.000	-.071	0.000	.071
1280.000	0.000	.491	0.000	.491	0.000	-.053	0.000	.053
1320.000	0.000	.740	0.000	.740	0.000	-.078	0.000	.078
1360.000	0.000	.646	0.000	.646	0.000	-.011	0.000	.011
1400.000	0.000	.492	0.000	.492	0.000	-.011	0.000	.011
1440.000	0.000	.365	0.000	.365	0.000	-.011	0.000	.011
1480.000	0.000	.255	0.000	.255	0.000	-.011	0.000	.011
1520.000	0.000	.176	0.000	.176	0.000	-.451	0.000	.451
1560.000	0.000	.151	0.000	.151	0.000	-.717	0.000	.717
1600.000	0.000	.077	0.000	.077	0.000	.150	0.000	.150

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE
VEHICLE DECELERATION: AIRFRAME
CRASH VICTIM: SINGLE MAN(5%)-SEAT

SEGMENT ANGULAR DISPLACEMENTS (DEG) IN VEHICLE REFERENCE

TIME	SEGMENT NO. 1 - MS				SEGMENT NO. 2 - CH			
(MSEC)	YAW	PITCH	ROLL	RES	YAW	PITCH	ROLL	RES
0.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
40.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
80.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
120.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
160.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
200.000	0.000	12.500	0.000	12.500	0.000	12.500	0.000	12.500
240.000	0.000	7.942	0.000	7.942	0.000	12.028	0.000	12.028
280.000	0.000	-13.910	0.000	13.910	0.000	6.289	0.000	6.289
320.000	0.000	-44.317	0.000	44.317	0.000	16.817	0.000	16.817
360.000	0.000	-69.196	0.000	69.196	0.000	23.936	0.000	23.936
400.000	0.000	-72.793	0.000	72.793	0.000	21.651	0.000	21.651
440.000	0.000	-47.244	0.000	47.244	0.000	12.236	0.000	12.236
480.000	0.000	17.878	0.000	17.878	0.000	4.963	0.000	4.963
520.000	0.000	74.731	0.000	74.731	0.000	2.061	0.000	2.061
560.000	0.000	86.557	0.000	86.557	0.000	7.127	0.000	7.127
600.000	0.000	70.345	0.000	70.345	0.000	12.624	0.000	12.624
640.000	0.000	35.979	0.000	35.979	0.000	15.652	0.000	15.652
680.000	0.000	.431	0.000	.431	0.000	15.235	0.000	15.235
720.000	0.000	-18.018	0.000	18.018	0.000	12.299	0.000	12.299
760.000	0.000	-14.197	0.000	14.197	0.000	9.509	0.000	9.509
800.000	0.000	3.502	0.000	3.502	0.000	8.108	0.000	8.108
840.000	0.000	26.235	0.000	26.235	0.000	7.840	0.000	7.840
880.000	0.000	45.398	0.000	45.398	0.000	8.536	0.000	8.536
920.000	0.000	56.679	0.000	56.679	0.000	9.932	0.000	9.932
960.000	0.000	58.964	0.000	58.964	0.000	11.509	0.000	11.509
1000.000	0.000	53.055	0.000	53.055	0.000	12.832	0.000	12.832
1040.000	0.000	40.961	0.000	40.961	0.000	13.651	0.000	13.651
1080.000	0.000	25.402	0.000	25.402	0.000	13.834	0.000	13.834
1120.000	0.000	9.515	0.000	9.515	0.000	13.336	0.000	13.336
1160.000	0.000	-3.701	0.000	3.701	0.000	12.320	0.000	12.320
1200.000	0.000	-11.539	0.000	11.539	0.000	11.093	0.000	11.093
1240.000	0.000	-12.994	0.000	12.994	0.000	9.957	0.000	9.957
1280.000	0.000	-8.520	0.000	8.520	0.000	9.069	0.000	9.069
1320.000	0.000	.537	0.000	.537	0.000	8.329	0.000	8.329
1360.000	0.000	10.862	0.000	10.862	0.000	8.060	0.000	8.060
1400.000	0.000	19.027	0.000	19.027	0.000	7.904	0.000	7.904
1440.000	0.000	25.169	0.000	25.169	0.000	7.747	0.000	7.747
1480.000	0.000	29.617	0.000	29.617	0.000	7.591	0.000	7.591
1520.000	0.000	32.580	0.000	32.580	0.000	3.316	0.000	3.316
1560.000	0.000	35.150	0.000	35.150	0.000	-.009	0.000	.009
1600.000	0.000	36.740	0.000	36.740	0.000	-8.738	0.000	8.738

1 DATE: 20-MAY-82

RUN DESCRIPTION: 5TH MAN-SEAT SEGMENT IN AIRFLOW (DANTE CONDITION NO. 4A)
AIRFLOW PLUS SUSTAINER AND STAPAC ROCKETS PLUS DROGUE CHUTE

VEHICLE DECELERATION: AIRFRAME

CRASH VICTIM: SINGLE MAN(5%)-SEAT

0 SPRING DAMPER FORCES

	SPRING DAMPER NO. 1		SPRING DAMPER NO. 2	
	SEG 1(MS) - SEG 2(CH)		SEG 1(MS) - SEG 2(CH)	
TIME (MSEC)	LENGTH (IN)	FORCE (LB)	LENGTH (IN)	FORCE (LB)
0.000	10.196	0.00	10.196	0.00
40.000	10.196	0.00	10.196	0.00
80.000	10.196	0.00	10.196	0.00
120.000	10.196	0.00	10.196	0.00
160.000	10.196	0.00	10.196	0.00
200.000	10.196	0.00	10.196	0.00
240.000	11.637	0.00	11.637	0.00
280.000	37.210	0.00	37.210	0.00
320.000	27.097	0.00	27.097	0.00
360.000	49.888	1186.59	49.888	1186.59
400.000	59.560	2347.22	59.560	2347.22
440.000	74.296	4115.57	74.296	4115.57
480.000	90.156	6018.78	90.156	6018.78
520.000	87.268	5672.13	87.268	5672.13
560.000	71.219	3746.27	71.219	3746.27
600.000	71.894	3827.23	71.894	3827.23
640.000	68.590	3430.85	68.590	3430.85
680.000	65.654	3078.48	65.654	3078.48
720.000	61.897	2627.66	61.897	2627.66
760.000	59.017	2282.06	59.017	2282.06
800.000	57.510	2101.24	57.510	2101.24
840.000	56.275	1952.97	56.275	1952.97
880.000	55.138	1816.60	55.138	1816.60
920.000	53.786	1654.33	53.786	1654.33
960.000	52.632	1515.89	52.632	1515.89
1000.000	51.801	1416.15	51.801	1416.15
1040.000	51.076	1329.08	51.076	1329.08
1080.000	50.422	1250.58	50.422	1250.58
1120.000	49.588	1150.60	49.588	1150.60
1160.000	48.824	1058.91	48.824	1058.91
1200.000	48.079	969.52	48.079	969.52
1240.000	47.396	887.55	47.396	887.55
1280.000	46.941	832.94	46.941	832.94
1320.000	45.639	676.70	45.639	676.70
1360.000	29.907	0.00	29.907	0.00
1400.000	12.937	0.00	12.937	0.00
1440.000	10.857	0.00	10.857	0.00
1480.000	29.368	0.00	29.368	0.00
1520.000	47.721	926.50	47.721	926.50
1560.000	37.522	0.00	37.522	0.00
1600.000	39.677	0.00	39.677	0.00

1 ELAPSED CPU TIME = 13.00 SECONDS

SUB	CALLS	TIME	%
MAIN3D	1	3	.23
INPUT	1	11	.85
CHAIN	2010	8	.62
DINT	41	187	14.38
PDAUX	2429	196	15.08
DAUX	2009	198	15.23
SETUP1	2009	26	2.00
CONTCT	2009	81	6.23
	2009	95	7.31
WINDY	4018	116	8.92
SPDAMP	2009	76	5.85
VISPR	2009	18	1.38
EJOINT	2009	11	.85
SETUP2	2009	14	1.08
DAUX11	2009	18	1.38
DAUX12	2009	14	1.08
DAUX22	2009	11	.85
FSMSOL	2009	18	1.38
OUTPUT	421	74	5.69
UPDATE	420	1	.08
DZP	2008	77	5.92
POSTPR	1	47	3.62
0TOTAL		1300	100.00

*EOR

```
1  CSA   NOS/BE L530H        L530H-CMR1 03/15/82
 18.14.24.GB19LME  FROM    /9L
 18.14.24.IP  00000128 WORDS - FILE INPUT  , DC 04
 18.14.24.GB1,T30,IO30,CM327000,STCSA.    L800764/
 18.14.24.BUTLER
 18.14.25.ACCOUNT TO BE CLOSED AT END OF MONTH
 18.14.25.CALL YOUR OCR
 18.14.25. INTERCOM BATCH JOB - NO DECK
 18.14.25.ATTACH,ATBM,ATBGBAIRFLOWBINARY1982,MR=1.
 18.14.25.AT CY= 001 SN=AFIT
 18.14.26.ATTACH,BPLT,CCPLOT56X,SN=ASD,ID=LIBRARY.
 18.14.26.AT CY= 999 SN=ASD
 18.14.26.ATTACH,AIRFLOW,ATBGBAIRFLOW5THINPUT,CY=3
 18.14.26..
 18.14.26.ATTACH,TAPE10,SMAERO,ID=FDLTR7457,SN=AFF
 18.14.26.DL,MR=1.
 18.14.27.AT CY= 999 SN=AFFDL
 18.14.27.MAP,ON.
 18.14.27.LIBRARY,BPLT.
 18.14.27.LDSET,PRESET=ZERO.
 18.14.27.ATBM,AIRFLOW,PL=12000.
 18.18.02.    STOP  1
 18.18.02.    275600 MAXIMUM EXECUTION FL.
 18.18.02.    13.020 CP SECONDS EXECUTION TIME.
 18.18.02.OP  00018176 WORDS - FILE OUTPUT , DC 40
 18.18.02.MS   18240  WORDS  (   65664 MAX USED)
 18.18.02.CPA      14.656 SEC.        11.943 ADJ.
 18.18.02.IO       11.525 SEC.         3.411 ADJ.
 18.18.02.CM     2192.903 KWS.        10.329 ADJ.
 18.18.02.CRUS                        25.685
 18.18.02.COST                $        1.69
 18.18.02.PP        8.281 SEC.     DATE 05/27/82
 18.18.02.EJ  END OF JOB, 9L  L800764.
..
FORMAT ERROR
```

APPENDIX C

THE INPUT DESCRIPTION FOR
THE AFAMRL ARTICULATED TOTAL BODY (ATB-IIIA) MODEL

The input description describes those features which are operational through Version 21 of the ATB Program. The ATB-IIIA Model was developed for the Air Force Aerospace Medical Research Laboratory, Wright Patterson Air Force Base, Ohio 45433 under Contract No. F33615-80-C-0511. It contains what J & J Technologies Inc. considers to be the best description of the program capabilities.

INPUT DESCRIPTION FOR THE AFAMRL ARTICULATED TOTAL BODY (ATB-IIIA) MODEL !
Version 21 06/24/82 !

Note: this report is supplied with '1' in column 1 for page skip control to allow for printing on various computer systems.

The following special symbols may differ on other systems:

"#" is used to indicate "not equal".
"<" is used to indicate "less than".
">" is used to indicate "greater than".
"!" is used to indicate "absolute value".

Any line with either of the symbols "!", "*" or "$" at the right indicates that a change has been made to this input description since that included in Calspan Report No. ZS-5881-V-3, "Validation of the Crash Victim Simulator", Volume 3, ! User's Manual, February 1982. !

The symbol "*" indicates that an item or card has been added to the ATB model input in such a manner that previous input decks are still acceptable as proper input for the current version of the program.

The symbol "$" indicates that changes in format of content are required to previous input decks to be acceptable as proper input for the current version of the program.

OUTLINE OF INPUT TO THE PROGRAM :

Cards A - Date and run description, units of input and output, control of restart, integrator and optional output.

Cards B - Physical characteristics of the segments and joints.

Cards C - Description of the vehicle motion.

Cards D - Contact planes, belts, air bags, contact ellipsoids, constraints, and symmetry options.

Cards E - Functions defining force-deflections, inertial spike, energy absorption factor, and friction coefficients.

Cards F - Allowed contacts among segments, planes, belts, air bags and contact ellipsoids.

Cards G - Initial orientations and velocities of the segments.

Cards H - Control of output of time history of selected segment motions and joint parameters.

Cards I - Control information for plotter output

Description of FORTRAN FORMAT Statements Used

At the beginning of the description of each card appears the FORTRAN FORMAT statement that specifies the structure of the input image for that card. The only format codes used by the ATB program are

nFw.d	(F to describe real data fields)
nIw	(I to describe integer data fields)
nAw	(A to describe alphanumeric data fields)
wX	(X to indicate a field to be skipped)

where: n, w and d are unsigned integer constants.

n is optional and is a repeat count used to denote the number of times the format code is to be used. If n is omitted, a value of one is assumed and the code is used only once.

w specifies the field width (number of columns on the card).

d normally specifies the number of decimal places to the right of the decimal point, i.e., the fractional part of the number. However, a decimal point supplied within the field will override the d specification.

/ is used to indicate the end of a card image and that the remaining fields are to be supplied on a succeeding card.

All variable names used follow the standard FORTRAN naming convention, i.e., those variables where the first letter of their name is A-H or O-Z are real (actually double precision on IBM and Univac computers and single precision on CDC computers) and those with I-N as their first letter are integer.

All real data have a Fw.0 format code which requires the use of a decimal point within the specified field to override the d=0 specification. On most computers F, D and E format codes are completely interchangeable for input which permits one to supply an exponential (power of ten) multiplier; e.g., 0.000001 may be supplies as 1.0D-6, provided that the exponential term is right adjusted within the field width. In all other cases, real data using the Fw.0 format code may appear anywhere within the field width. All blanks are assumed to be zero and therefore ignored. A blank field will therefore input a value of zero.

All integer data use a Iw format code and must be right adjusted, i.e., must appear in the rightmost columns of the field.

Several names, titles and other descriptive items are alphanumeric data and use the Aw format code. Here blanks are spaces and the actual characters desired may appear anywhere within the field.

A. Main Program Input

Card A.1.a	FORMAT (3A4, 2I4, F8.0)
DATE(I),I=1,3	Date of the run (12 characters).
IRSIN	Restart input unit No. If blank or zero, all input to be supplied on Cards A.3 to Cards H.7. If nonzero (suggested value = 4), input will be supplied from a previous restart tape and Cards A.1.b,c and A.2.
IRSOUT	Restart output unit No. If nonzero (suggested value = 3), records will be written on this output unit for future restart runs. An initial record containing all input and initialization data will be written plus a time point record at every time interval as specified by DT on Card A.4.
RSTIME	Restart time (sec) required if IRSIN ≠ 0. Should be nonzero and an integer multiple of DT on Card A.4. Program will read records from the previous restart tape up to and including this time, make changes per Card A.2 and continue operation from there.
Cards A.1.b - A.1.c	FORMAT (20A4 / 20A4) **
COMENT(I),I=1,40	Description of the run (160 characters on two cards).

** Any FORMAT marked in this manner indicates that columns 73-80 of that card are used for input and should not be used for identification.

Cards A.2 are required only if IRSIN > 0, in which case all other input as specified on Cards A.3 to H.7 are bypassed. Two sets of A.2 (each terminated with a blank card) are required. The first set is processed after the initial input record is read from input unit IRSIN and, if IRSOUT # 0, before the input record is written on output unit IRSOUT. The second set is processed after the time point record for TIME = RSTIME has been read and, if IRSOUT # 0, after the same record is written on output unit IRSOUT, but before the program resumes operation.

Cards A.2.a - A.2.n	FORMAT(A8, 4I4, 2(F8.0, I8, A8))
AVAR	Alphanumeric name (left adjusted in field) of variable to be redefined for restart. Program is capable of changing any variable in the labeled common blocks as used after all initialization has been performed. The user should ascertain that changing this variable is valid for the program.
INDEX(I),I=1,3	The array indices, if any, of the variable. Must agree in number and the values must be less than or equal to the dimensions of the variable. Blank or zero for no dimension.
ITYPE	Supply 1,2 or 3 to indicate that the new value is to be real(RR), integer(II) or alphanumeric(AA). Must agree with the type of the variable within the program.
RR,II, or AA	New value of the variable AVAR to be supplied in the appropriate field determined by the value of ITYPE.
RROLD,IIOLD or AAOLD	The previous value of the variable AVAR in the appropriate field according to the itype value. Integer or alphanumeric data will be tested exactly, real data to 5 significant digits. If the current value is different, the program will terminate with an error message. If zero or blank is supplied, no check is performed.

These A.2 Cards will be processed until a blank value for AVAR is encountered. No further input is required.

Card A.3	FORMAT (3A4, 4F12.0)
UNITL	Unit of length (4 characters).
UNITM	Unit of force (mass) (4 characters).
UNITT	Unit of time (4 charcacters).

Note : UNITL, UNITM and UNITT should correspond to the user's inputs. Throughout this description, inches, pounds and seconds (in, lbs and sec) are used as sample units.

GRAVTY(I),I=1,3	The x, y and z components (in/sec**2) of the gravity vector. Normally this is used as the gravity force vector acting on the segments. This vector defines the inertial or ground reference coordinate system to be used by the program. The orientation of other coordinate reference systems (e.g., vehicle and local segment) are defined later with respect to this inertial reference coordinate system. One can therefore define any desired coordinate systems to meet individual requirements.
G	The value of g (in/sec**2). If blank or zero, the magnitude of the gravity vector will be used. Supplying the value of G permits one to specify a different gravity vector above (e.g., zero) for special applications.
Card A.4	FORMAT (2I4, 4F8.0)
NDINT	Number of iterations for final convergence test of the integrator Subroutine DINT (minimum value = 2, suggested value = 4).
NSTEPS	Number of integration steps (or output time points) for the integrator routine. May be zero to obtain initial conditions.
DT	Main Program time interval for integrator routine output (sec). Total time of run will be NSTEPS*DT seconds with Main Program unit 1, printer plot and optional output produced every DT seconds.
H0	Initial integrator step size (sec).

Card A.4 (continued)

HMAX	Maximum integrator step size (sec). For best efficiency DT should be an integral multiple of HMAX and HMAX a power of two multiple of H0. (suggested value = 0.001 sec)
HMIN	Minimum integrator step size (sec). If a fixed step size is desired, set HMIN greater than HMAX, and step size will double from H0 until HMAX is achieved.

Card A.5 FORMAT (36I2)

NPRT(I),I=1,36 An array of indicators that control various optional output features of the program. Generally, a blank or zero value indicates no output for that item and a value of one will produce output each time the routine is executed. The printed output produced by elements 8-28 is intended for diagnostic or "check out" purposes only, can produce large amounts of output and should not be used for long or production runs. It is not completely labeled and one should consult the listing of the subroutine for a description of the items that are printed.

The NPRT Array (* - see notes below)

Element No.	Subroutine	Output produced
1 (1*)	Main	Output unit No. 1
2 (1*)	Main	Subroutine ELTIME table
3 (1*)	Main	Subroutine PRINT output
4 (3*)	OUTPUT,POSTPR	Output unit No. 8, plots
5 (1*)	PRIPLT	y-z view printer plots
6 (1*)	PRIPLT	x-z view printer plots
7 (1*)	PRIPLT	x-y view printer plots
8 (2*)	DAUX	IJK, RHS and C arrays
9	DAUX	Subroutine PRINT output
10	IMPULS	diagnostic output
11	SETUP1	U2,V1 arrays
12	VISPR	diagnostic output
13	PRIPLT	CJOINT array
14	WINDY	wind forces
15	BELTG	diagnostic output
16	HBELT	harness-belt forces
17	EDEPTH	diagnostic output
18	not used	
19	not used	
20	CHAIN	SEGLP,SEGLV
21	AIRBAG	diagnostic output
22	AIRBG1	diagnostic output
23	BINPUT	HA and HB arrays
24	UPDATE	roll-slide test output
25	DINT	convergence test data
26 (4*)	DINT,POSTPR	tabular time history output
27	EQUILB	intermediate results
28 (5*)	HPTURB	harness belt forces
29	AIRFLW	airflow forces and torques
30	WINDY	STAPAC rocket forces
36 (6*)	CHAIN	controls drift of locked joints

Notes Concerning Elements of the NPRT Array

1* For elements 1,2,3,5 and 6, the value indicates the frequency, zero for no output (for element no. 2, the ELTIME table will be printed once at the end of the run), and a nonzero positive value (n) will produce output every n*DT (from Card A.4) seconds.

2* A value of NPRT(8) = 2 will print the designated arrays before and after the first call to Subroutine FSMSOL only.

3* The value of NPRT(4) is used (after Version 18a) to control

(1) Write the tabular time histories (specified by Cards H and the allowed contacts on Cards F) on either
   (a) the multiple output units (No. 21 and up) by Subroutine OUTPUT, or
   (b) the primary output unit (No. 6) by Subroutine HEDING.

(2) Store the time history data on output unit No. 8 by Subroutine OUTPUT to be later used by Subroutine POSTPR.

(3) Generate plots of the time history data (specified on Cards I) by Subroutine POSTPR.

The permissible values of NPRT(4) range from -3 to +4 as follows:

	Supplied Value for NPRT(4)							
	+4	+3	+2	+1	0	-1	-2	-3
1 Control Cards								
Multiple output units	yes	no	no	yes	yes	no	no	no
Output unit No. 8	yes	yes	yes	yes	no	yes	yes	yes
2 Card Input								
Cards B.1-H.7	yes	yes	yes	yes	yes	no	no	no
Card H.8	no	yes	yes	yes	no	yes	yes	yes
Cards I	no	yes	no	yes	no	yes	no	yes
3 Main Program Operation								
Integrate and/or restart	yes	yes	yes	yes	yes	no	no	no
Call Subroutine POSTPR	no	yes	yes	yes	no	yes	yes	yes
4 Print time histories								
Multiple output units	yes	no	no	yes	yes	no	no	no
Primary output unit	no	yes	yes	no	no	no	yes	yes
5 Output unit No. 8								
Write (Sub OUTPUT)	yes	yes	yes	yes	no	no	no	no
Read (Sub POSTPR)	no	yes	yes	yes	no	yes	yes	yes
6 Generate plots (Cards I)	no	yes	no	yes	no	yes	no	yes

4* NPRT(26) controls the frequency of the tabular time history output. Values of 0,1 or 2 are permissible to control

(a) If the tabular time histories are printed on the multiple output units 21 and up (NPRT(4) = 0,1 or 4), the value of NPRT(26) controls the frequency of the output as follows:
 0 will print one line every DT (from Card A.4) seconds;
 1 will print at the end of each successful integration step;
 2 will print at every intermediate time point of each step.

(b) If Output unit No. 8 is generated (NPRT(4) > 0), records are written at the end of each integration step if NPRT(26) is 0 or 1, and at every intermediate time point if NPRT(26) = 2.

(c) If the tabular time histories are printed from Output unit No. 8 (NPRT(4) = +2,+3,-2 or -3), a value of NPRT(26) equal to
 0 will print one line every DT (from Card A.4) seconds;
 1 will print at the end of each successful integration step;
 2 will print at every intermediate time point of each step.

5* NPRT(28) controls the frequency and level of diagnostic harness belt forces output produced. Values of 0,1,2 and 3 are allowed as follows: (each value includes output of all lower values)

(0) - Produces a table of the final harness belt forces at each point in play at the time points as output is produced by Subroutine PRINT as specified by NPRT(3).

(1) - Prints a table of the final harness belt forces at each point in play at the same time points as output is produced by Subroutine PRINT as specified by NPRT(3).

(2) - Prints a table of the harness belt forces at each point in play for every iteration step of Subroutine HPTURB.

(3) - Prints the RHS, IJK and C arrays before the call to FSMSOL at each iteration step at each time point of HPTURB.

6* A nonzero value for NPRT(36) triggers Subroutine CHAIN to recompute the direction cosine matrices and angular velocity of adjacent segments connected by locked joints so as to prevent drift of the locked joint axes. No diagnostic output is produced.

If NPRT(4) is negative, input Cards B.1-H.7 should not be supplied.

B. Subroutine BINPUT

Card B.1	FORMAT (2I6, 8X, 5A4)
NSEG	The number of segments for the crash victim. The maximum value is 30, but this includes one for the ground, NBAG airbags, and the new segments (including the primary vehicle) for which prescribed motion is defined on Cards C.
NJNT	The number of joints (maximum = 29). Note: normally NJNT = NSEG-1, but joint numbers NVEH-1 and NGRND-1 may be used to connect the vehicle and the ground to lower numbered segments.
BDYTTL(I),I=1,5	Description of the crash victim (20 characters).
Cards B.2.a1 - B.2.n1 (NSEG cards)	FORMAT (A4, 1X, A1, 10F6.0, I4)

Each card (I) for I = 1, NSEG will contain input data for the Ith segment. The segment identifying numbers (I) will be referred to on later input cards.

SEG(I)	An abbreviation of the nomenclature of the Ith segment (4 characters).
CGS(i)	The plot symbol of the segment c.g. (1 character).
W(I)	The weight of the segment (lbs).
PHI(J,I),J=1,3	The principal moments of inertia of the segment about the x, y, and z axes of the segment (lbs-sec**2-in). There are no restrictions on the values of W(I) or PHI(J,I), they may be negative or zero. If any component is zero, it is assumed that the system is suitably constrained so that the system matrix is non-singular.
BD(J,I),J=1,3	The x, y, and z semiaxes of the segment contact ellipsoid (in).

Cards B.2.a1 - B.2.n1 (continued)

BD(J,I),J=4,6	The location of the center of the segment contact ellipsoid, with respect to the center of gravity of the segment, in the local body segment reference(in). These primary contact ellipsoids are given the same indentifying number as the segment. They may be redefined with an arbitrary orientation on Cards D.5.

Prior to Version 20 (January 1980), the ATB program assumed that that principal axes (defined such that the moment of inertia matrix is diagonal) coincided with the local geometric axes of each segment. To handle those situations where this is not the case, LPMI(I) has been added to card B.2.i1 which, if nonzero, indicates that the principal axes are rotated from the local geometric axes for segment No. I and that an additional input card B.2.i2 must immediately follow to specify the rotation. Since it is desirable that input defining points on a segment be supplied with respect to the local geometric axes and, also, not to invalidate previous input decks, the program (Subroutine ROTATE) will transform all data that has been defined with respect to the local geometric axes to the principal axes in a manner that is transparent to the user. Also, all standard output, where applicable, will be transformed back to the local geometric axes.

Cards B.2.a1 - B.2.n1 (continued)

LPMI(I)	An integer which, if nonzero, incicates that the principal axes for segment No. I are rotated from the local geometric axes. If LPMI(I) ≠ 0, Card B.2.i2 must immediately follow this Card B.2.i1. If LPMI(I) is zero or blank, Card B.2.i2 is not required.
Card B.2.i2	FORMAT (12X, 3F6.0)
YPRPMI(J,I),J=1,3	The yaw, pitch and roll (degrees) of the principal axes with respect to the local geometric axes of segment No. I.

IF NJNT is zero on Card B.1, Cards B.3 - B.5 are not required.

Cards B.3.a1 - B.3.j1 FORMAT (A4, 1X, A1, 2I4, 6F6.0)
(NJNT sets of cards, 2 cards per set. the first card of each set is described on this page, the second card on the next page.)

Each card (J) for J = 1, NJNT will contain input data for the Jth joint. The joint identifying numbers (J) will be referred to on later input cards.

JOINT(J)	An abbreviation of the nomenclature of the Jth joint (4 characters).
JS(J)	Plot symbol of the joint location (1 character).
JNT(J)	Magnitude indicates the number of the segment that is connected to segment J+1 by joint J. If negative, joint J is associated with a flexible element. If zero, segment J+1 is the reference segment of another body. (|JNT(J)| < J+1).
IPIN(J)	0 - there are to be no constraints on joint J. 1 - joint J is pinned (hinge). 2 - joint J is not pinned (ball and socket). 3 - joint J is globalgraphic (ball and socket). 4 - joint J is an Euler joint. Nonzero values for IPIN may be supplied as positive or negative to indicate that the initial condition of the joint is unlocked (positive) or locked (negative). An Euler joint may use the globalgraphic option by specifying IGLOB = 1 on Card F.4.a. The initial state of an Euler joint is set by use of IPIN as follows

IPIN	IEULER	state
4	8	free
- 4	7	all axes locked
- 5	6	spin free, others locked
- 6	5	nutation free, others locked
- 7	4	precession free, others locked
- 8	3	spin locked, others free
- 9	2	nutation locked, others free
-10	1	precession locked, others free

where precession is about the z axis of the joint reference (YPR1) in segment No. JNT(J), nutation about the resultant x axis, and spin about the resultant z axis of the joint reference (YPR2) in segment No. J+1.
If IPIN is less than -3, program will set IEULER as above and then set IPIN = -4.

Cards B.3.a1 - B.3.j1 (continued)

SR(I,2*J-1),I=1,3	Coordinates of location of joint J (in) in the local reference system of segment JNT(J).
SR(I,2*J),I=1,3	Coordinates of location of joint J (in) in the local reference system of segment J+1.

Cards B.3.a2 - B.3.j2 FORMAT (14X, 9F6.0, 6I2) **
(One of these cards must follow each card from previous page.)

YPR1(I,J),I=1,3	The rotation angles (degrees) about the z, y and x axes, respectively, of the local reference of segment No. JNT(J) to specify the principal axes of joint J. The order of these rotations is specified by ID1 below.
YPR2(I,J),I=1,3	The rotation angles (degrees) about the z, y and x axes, respectively, of the local reference of segment No. J+1 to specify the principal axes of joint J. The order of these rotations is specified by ID2 below. The z axis is the reference axis to define flexure. The y axis is used as the pin axis except for the special Euler joints. The xy plane is used for globalgraphic joints with x as the reference axis.
YPR3(I,J),I=1,3	The center of symmetry (degrees) for Euler joints (used only if |IPIN(J)| = 4) supplied in the order precession, nutation and spin. Joint torques for Euler joints are a function of the deviation of the Euler angles from these angles. Previous versions (before 18a) of program assumed values of zero.
ID1(I,J),I=1,3	Values of 1,2 and 3, corresponding to the x, y and z axes, specifying the order of the axes about which the rotations given in YPR1 are to be performed. Zero or blank values will default to the order 3,2 and 1 to specify the normal yaw, pitch and roll sequence, i.e., yaw about origianl z axis using YPR1(1,J), pitch about resultant y axis using YPR1(2,J), roll about resultant x axis using YPR1(3,J). The same axis cannot be specified for two or more consecutive rotations. However, the third axis may be the same as the first, provided it is supplied as a negative number, in which case the unused value of YPR1 will be used about the indicated axis. e.g., values of 3.1 and -3 will specify the normal Euler rotations, where YPR1 is supplied in the order precession, spin and nutation to compute precession (YPR1(1,J)) about original z axis, nutation (YPR1(3,J)) about resultant x axis, and spin (YPR1(2,J)) about resultant z axis.
ID2(I,J),I=1,3	Specifies the order of the rotations given by YPR2 identical to the description of ID1.

Cards B.4.a - B.4.j FORMAT (2 (4F6.0, F12.0))

(NJNT sets of cards, one for each joint J. If |IPIN(J)| # 4, each set reads values for 3*J-2 and 3*J-1 on one card only. If |IPIN(J)| = 4 , joint J is an Euler joint and a second card is necessary to read values for 3*J.)

SPRING(I,3*J-2), I=1,5	The flexural spring characteristics for joint J. If J is an Euler joint, the spring characteristics about the precession axis. If JOINTF(J) # 0 (on Card F.5.a), these values are not used and should be zero.
SPRING(I,3*J-1), I=1,5	The torsional spring characteristics for joint J. If J is an Euler joint, the spring characteristics about the nutation axis.
SPRING(I,3*J), I=1,5	Second card of each set is required only if J is an Euler joint, the spring characteristics about the spin axis.
I=1	Linear spring coefficient (in-lbs/deg**2).
I=2	Quadratic spring coefficient (in-lbs/deg**2).
I=3	Cubic spring coefficient (in-lbs/deg**3).
I=4	Energy dissipation coefficient (dimensionless). A value of 1.0 specifies no loss. A value of 0.0 specifies maximum loss.
I=5	Joint stop location with respect to the center of symmetry (deg). For a value of zero the routine will use only the linear spring coefficient and will apply the energy dissipation factor.
ANG(I,J),I=1,3	The approximate initial rotation angles, in the order precession, nutation and spin, (degrees) for joint J which is an Euler joint. These are used as the initial angles for the memory mode used by Subroutine EULRAD and need not be exact. The values are absolute and not relative to the center of symmetry.

Cards B.5.a - B.5.j FORMAT (5F6.0, 18X, 2F6.0)
(NJNT sets of cards, one for each joint J. If |IPIN(J)| # 4, values for 3*J-2 are on one card only. If |IPIN(J)| = 4, J is an Euler joint and values for 3*J-1 and 3*J are required on a second and third card of each set.)

VISC(I,3*J-2), I=1,7	The viscous characteristics for joint J. If J is an Euler joint, the viscous characteristics about the precession axis.
VISC(I,3*J-1), I=1,7	The second card of each set is required only if J is an Euler joint, the viscous characteristics about the nutation axis.
VISC(I,3*J) I=1,7	The third card of each set is required only if J is an Euler joint, the viscous characteristics about the spin axis.
I=1	Viscous coefficient (in-lb-sec/deg).
I=2	Coulomb friction coefficient (in-lb).
I=3	Relative angular velocity of joint at which full coulomb friction is applied (deg/sec). Must be greater than 0.
I=4	T1: the maximum torque (in-lbs) allowed for a locked joint (or Euler axis). If exceeded, the joint will unlock. If T1 = 0, the test will not be performed. Note: if joint J is locked, if T1=0, and if Subroutine EQUILB is called, then VISC(4,3*J-2) will be set by Subroutine EQUILB (see description under Cards G.6).
I=5	T2: the minimum torque (in-lbs) allowed for joint J to remain unlocked. If T2 = 0, the test will not be performed.
I=6	T3: the minimum angular velocity (rad/sec) necessary for joint J to remain unlocked. If T3 = 0, the test will not be performed.
I=7	e = (1+u)/2 where u is the classical coefficient of restitution to be used for the impulse option if the joint hits the joint stop (o<e<1 or -1<u<+1). A value of e = 0 means that the impulse option will not be exercised for this joint.

Cards B.6.a - B.6.i (nseg cards)	FORMAT (12F6.0)
SGTEST(1,1,I)	Magnitude test for the angular velocity of segment No. I (rad/sec).
SGTEST(2,1,I)	Absolute error test for the angular velocity of segment No. I (rad/sec).
SGTEST(3,1,I)	Relative error test for the angular velocity of segment No. I (dimensionless).
SGTEST(1,2,I) (2,2,I) (3,2,I)	Same as above, but for the linear velocity of segment No. I (in/sec)
SGTEST(1,3,I) (2,3,I) (3,3,I)	Same as above, but for the angular acceleration of segment No. I (rad/sec**2).
SGTEST(1,4,I) (2,4,I) (3,4,I)	Same as above but for the linear acceleration of segment No. I (in/sec**2).

These convergence tests are performed by Subroutine DINT on the resultant of the derivative vectors. The linear velocities and accelerations are computed only for reference segments (i.e., segment No. 1 and those segments I where JNT(I-1) = 0), therefore any test numbers supplied for linear velocities and accelerations of other segments will be ignored. The tests for convergence are performed in the following order :

1) If the magnitude test is zero, no testing is done for that variable.

2) If the magnitude of the resultant vector is less that the magnitude test, the routine has passed the convergence test for that variable.

3) If the absolute error test is greater than zero, and the magnitude of the absolute error (difference between the predicted and computed vector) is less than the absolute error test, the routine has passed the convergence test for that variable.

4) If the relative error of the magnitude of the absolute error compared to the magnitude of the computed vector is greater than the relative error test, the convergence test has failed.

If NFLX # 0, Cards B.7 are required. Each flexible element as defined on Cards B.3 contains at least three connected segments consisting of a reference segment, one or more interior segments and a terminating segment. Each joint in the element should have a negative value for JNT, and the number of interior segments will be one less than the number of negative values of JNT for each element. NFLX is the total number of interior segments of all flexible elements.

Card B.7.a FORMAT (18I4)

NFX	The number of interior segments for which HF arrays are to be supplied.
KNT(K),K=1,NFX	The interior segment identification numbers in the order of the JF arrays to be supplied. If the values of NFX and KNT are not consistent with the negative values of JNT on Cards B.3, the program will terminate with an appropriate error message.

Cards B.7.b - B.7.n FORMAT (12F6.0)
(4*NFX cards, 4 cards for each segment in the order as they are defined in the KNT vector.)

(HF(I,J,K),J=1,12) ,I=1,4	The coefficients of the quadratic form function used to define the orientation of interior segment KNT(K) with respect to reference segment of the element.

Form the column vector v with four components y,p,r and 1, where y,p,r are the yaw, pitch and roll of the terminating segment relative to the reference segment. Let H be a symmetric 4x4 matrix such that f(v) = 1/2 v.Hv represents a quadratic scalar function of the variables y,p and r in radians. Thus

```
  yaw of segment KNT(K) = 1/2 v.HF(I,J  ,K)v
pitch of segment KNT(K) = 1/2 v.HF(I,J+4,K)v
 roll of segment KNT(K) = 1/2 v.HF(I,J+8,K)v     (I,J=1,4)
```

C. Subroutine VINPUT

These C Cards are used to prescribe the motion (acceleration time history) of specified segments. Normally only one set is supplied with MSEG (last item on Card C.2) equal to zero (or blank) to prescribe the motion of the primary vehicle (segment No. NSEG+1). However, multiple sets may be supplied (maximum = 6) with MSEG = 0 on the last set to denote the primary vehicle.

Several options are available for each prescribed motion. The required inputs for each option are as follows:

Option 1: half sine wave deceleration impulse (NATAB = 0)

Required inputs - Card C.1; Card C.2.a: ANGLE(1), ANGLE(2), VIPS, VTIME, X0, NATAB=0, MSEG.

Option 2: tabular unidirectional deceleration (NATAB > 0)

Required inputs - Card C.1; Card C.2.a: ANGLE(1), ANGLE(2), VIPS, X0, NATAB>0, AT0, ADT, MSEG; Cards C.3.

Option 3: six degree of freedom deceleration (NATAB < 0 and LTYPE = 0)

Required inputs - Card C.1; Card C.2.a: ANGLE(1), ANGLE(2), ANGLE(3), VIPS, X0, NATAB<0, AT0, ADT, MSEG; Card C.2.b: LTYPE=0, VMEG; Cards C.4.

Option 4: spline fit position, velocity or acceleration data (NATAB < 0 and LTYPE > 0)

Required inputs - Card C.1; Card C.2.a: NATAB<0, AT0, ATD, MSEG; Card C.2.b: LTYPE>0, LFIT, NPTS; Cards C.5.

These options and their required inputs have been established in such a manner that any previous input decks are still acceptable as input, except that Card C.2.b was added for option 3 for Version 18 of the ATB program. For Version 19, Card C.2.b has been modified and Option 4 (Cards C.5) and the multiple prescribed motion were added.

Card C.1 FORMAT (20A4) **

VPSTTL(I),I=1,20	Description of the crash vehicle deceleration (80 characters).

Card C.2.a	FORMAT (8F6.0, I6, 2F6.0, I6)
ANGLE(I),I=1,3	Options 1 and 2: ANGLE(1) and ANGLE(2) (deg) are the azimuth and elevation (oblique angles) of the direction of the deceleration impulse. The initial yaw, pitch and roll of the vehicle are assumed to be zero. Option 3: the three angles are the initial yaw, pitch and roll (deg) of the vehicle.
VIPS	The initial velocity (in/sec) of the vehicle. For option 1, a negative value may be supplied to indicate that the vehicle will accelerate from an initial velocity of zero to -VIPS.
VTIME	The time duration (sec) of the half sine wave deceleration impulse. Cannot be zero or blank for option 1.
X0(i),i=1,3	The x, y and z coordinates (in) of the vehicle reference origin in inertial reference.
NATAB	Number of time points of vehicle deceleration data to be supplied or generated by the program. The algebraic sign of NATAB determines the option of prescribed motion as follows: If NATAB = 0 (Option 1), the impulse is an analytical half sine wave function that (VIPS>0) decelerates the vehicle from an initial velocity of VIPS to zero, or (VIPS<0) accelerates the vehicle from an initial velocity of zero to -VIPS in VTIME sec. If NATAB > 0 (Option 2), the vehicle motion is unidirectional and NATAB values of linear deceleration are to be supplied on Cards C.3. NATAB should be odd, maximum value is 99. If NATAB < 0 (Options 3 and 4), the prescribed motion is specified on either Cards C.4 or C.5. here MATAB (=-NATAB) is the number of time points of acceleration data to be supplied on Card C.4 or computed from the spline fit data on Cards C.5 (maximum value of MATAB is 101).
AT0,ATD	The first time and fixed time interval (sec) for the table of acceleration data that for (Option 3) is to be supplied on Cards C.4, or (Option 4) is to be computed from the spline fit data to be supplied on Cards C.5.

MSEG	The segment number associated with this prescribed deceleration time history. If MSEG is less than or equal to NSEG (Card B.1), the motion of segment No. MSEG as defined on Cards B.2 will be prescribed (Note: extreme caution must be exercised in using this option.) If MSEG > NSEG, the sets must be supplied in the order MSEG=NSEG+1, NSEG+2, etc., to prescribe the motion of secondary vehicle segments. If MSEG = 0, this is the last (or only) set of C Cards to be supplied to prescribe the motion of the primary vehicle whose segment No. will be one greater than NSEG or the last value of MSEG that was greater than NSEG.

Card C.2.b FORMAT (3I6, 22X, 3F10.0)

This card is required only if NATAB < 0 (Options 3 and 4). Note: this card was added for Version 18 of the ATB program to supply the initial angular velocity and revised for Version 19. A blank card should be inserted here for any previous input data decks that utilized the six degree of freedom option on Cards C.4.

LTYPE	Option 3: supply a value of zero or blank for the six degree of freedom input on Cards C.4. Option 4: a value of 1,2 or 3 specifies that the tables to be supplied on Cards C.5. are (1) position, (2) velocity or (3) acceleration data for each time point.
LFIT	The degree of the polynomials to be spline fitted through the time point data on Cards C.5. A value of 0, 1, 2 or 3 may be used but the degree should be sufficient to produce continuity for the computed velocity values. For LTYPE = 1, supply LFIT = 2 or 3. For LTYPE = 2, supply LFIT = 1,2 or 3. For LTYPE = 3, supply LFIT = 0,1,2 or 3. Note: for LFIT = 0, a constant value is assumed from the current time value to the next time value but round off errors in time computations may not produce the time desired.
NPTS	The number of actual time point data to be supplied on Cards C.5.
VMEG(I),I=1,3	The three components of the initial angular velocity (deg/sec) about the local x, y and z axes of the vehicle.

Cards C.3.a - C.3.n FORMAT (12F6.0)

These cards are required only if NATAB > 0 (Option 2).

DEC(I),I=1,NATAB The values of deceleration (g's) of the vehicle for the NATAB equally spaced time points

T(I) = AT0 + (I-1)*ADT for I=1,NATAB.

Supply 12 values per card, use as many cards as necessary. Since a Simpson's integration is used to compute velocity and position, the value of NATAB must be odd. The last value , ATAB(1,NATAB) will be used to integrate for any time greater than T(NATAB-1).

Cards C.4.a - C.4.m FORMAT (10X, 6F10.0)

These cards are required if NATAB < 0 and LTYPE = 0 (option 3).

MATAB cards are required where MATAB = -NATAB. each card (I) will contain data for equally spaced time points T(I), where

T(I) = AT0 + (I-1)*ADT for I=1,MATAB.

ATAB(J,I),J=1,3 The x, y and z components (g's) of the linear deceleration of the vehicle origin at time T(I).

ATAB(J,I),J=4,6 The angular accelerations (deg/sec**2) about the local x, y and z axes of the vehicle at T(I).

Note: the program will integrate for velocity and position beyond the last time point using the values at that point. The program will print at input time a complete table of the integrated velocity and position from the supplied acceleration data. The integration procedure is not identical to the program integrator.

Cards C.5.a - C.5.m FORMAT (7F10.0)

These cards are required if NATAB < 0 and LTYPE > 0 (Option 4).

(LTYPE-1) cards are required first to set initial conditions followed by NPTS cards containing time point data.

If LTYPE=1, the input table is position data for NPTS time points.

If LTYPE=2, the first card is the initial position data, which is followed by the input table of velocity data for NPTS time points.

If LTYPE=3, the first card is the initial position data, the second card is the initial velocity data, which is followed by the input table of acceleration data for NPTS time points.

T(I)	The time (sec) for the data on this card. If this card is for initial condition data, T(1) should be zero or blank, the times should be in ascending order but do not have to be equally spaced.
XYZ(J,I),J=1,3	If position data, the x, y and z coordinates (in) of the vehicle origin in the inertial reference coordinate system for time T(I). If velocity data, the x, y and z components (in/sec) of velocity of the vehicle origin in inertial reference for time T(I). If acceleration data, the x, y and z components (in/sec**2) of the deceleration of the vehicle origin in inertial reference for time T(I).
XYZ(J,I),J=4,6	If position data, the yaw, pitch and roll (deg) of the vehicle coordinate reference axes with respect to the inertial reference. If velocity data, the components of angular velocity (deg/sec) about the local x,y,z axes. If acceleration data, the components of angular acceleration (deg/sec**2) about the local x,y and z axes.

Note: the program will spline fit the NPTS data points for each of the six components independently to produce a piece-wise set of polynomials of degree LFIT. These polynomials are then evaluated to produce a set of acceleration tables at MATAB(= -NATAB) equally spaced time points equivalent to the six degree of freedom (Option 3) data of Cards C.4. The program will then print at input time a complete table of the integrated velocity and position from these generated acceleration data. The integration procedure used is not identical to the program integrator.

D. Subroutine SINPUT

Card D.1 FORMAT (10I6)

NPL	The number of planes describing contact panels (30 maximum).
NBLT	The number of belts used to restrain the crash victim (8 maximum).
NBAG	The number of airbags used to restrain the crash victim (max = 5, max MSEG+NBAG = 28, where MSEG is either NSEG or largest MSEG from Cards C.2.a).
NELP	The number of contact ellipsoids to be supplied on Cards D.5 (40 maximum).
NQ	The number of constaints to be supplied on Cards D.6 each constraint type 5 will be considered as two constraints requiring two sets of Cards (note: the program will later increment NQ by 1 for each NF(1) = 0 on Cards F.1.b and F.3.b and the final maximum on NQ is 12).
NSD	The number of spring dampers to be supplied on Cards D.8 (20 maximum).
NHRNSS	Number of harness-belt systems to be supplied on Cards F.8.b-F.8.d. May be zero or blank. Maximum value = 5. Note: in Version 12 (for WPAFB) this variable was supplied on Card F.8.a.
NWINDF	The number of wind force functions to be supplied on Cards E.6.a-E.6.n. May be zero. Note: in Version 12, this variable was supplied on Card E.5.
NJNTF	The number of joint restoring force functions to be supplied on Cards E.7.a-E.7.n. May be blank or zero. Note: in Version 12, this variatle was supplied on Card E.5.
NFORCE	The number of force functions to be supplied on Cards D.9.

If NPL is nonzero on Card D.1, NPL sets of Cards D.2 are required.

Card D.2.a	FORMAT (I4, 4X, 5A4)
J	The plane identification number, must be supplied as consecutive integers 1 to NPL.
PLTTL(I,J),I=1,5	A 20 character description of the Jth panel.
Cards D.2.b - D.2.d	FORMAT (3F12.0)
P1(I),I=1,3	The x, y and z coordinates of point P1 in vehicle (or segment to which plane is attached) reference (in).
P2(I),I=1,3	The x, y and z coordinates of point P2 in vehicle (or segment to which plane is attached) reference (in).
P3(I),I=1,3	The x, y and z coordinates of point P3 in vehicle (or segment to which plane is attached) reference (in).

where P1, P2 and P3 are three of the corners of a parallelogram such that the edge P1P2 is less than 180 degrees clockwise (as viewed from the external surface) from the edge P1P3. Note: any previous input deck in which the vector P2-P1 is not perpendicular to the vector P3-P1 will now produce different results.

If NBLT is nonzero on Card D.1, NBLT sets of Cards D.3 are required.

Card D.3.a		FORMAT (5A4)
	BLTTTL(I,J),I=1,5	A 20 character description of the Jth belt.
Card D.3.b		FORMAT (6F12.0)
	BELT(I,J),I=1,3	x, y, and z coordinates, in vehicle (or segment to which belt is anchored) reference, of anchor point A for the Jth belt (in).
	BELT(I,J),I=4,6	x, y, and z coordinates, in vehicle (or segment to which belt is anchored) reference, of anchor point B for the Jth belt (in).

Note: the program must pass a plane through the three points, anchor point A, anchor point B, and a fixed point on the contacted body segment. If anchor points A and B coincide, they must be separated slightly for input such that the desired belt plane will be defined.

Card D.3.c		FORMAT (5F12.0)
	BELT(I,J),I=7,9	x, y, and z coordinates, in local body segment reference (but with respect to ellipsoid center, not c.g.), of the fixed contact point on the body segment for the Jth belt (in).
	BELT(10,J)	Currently not used by the program.
	BELT(11,J)	Belt slack (in). the slack, when added to the initial geometric length, results in the initial belt length. If desired, the initial belt length may be inputted as a negative number and the program will compute the slack.

If NBAG is nonzero on Card D.1, NBAG sets of Cards D.4 are required by Subroutine AIRBG1.

Card D.4.a	FORMAT (5A4, I4)
BAGTTL(I,J),I=1,5	A 20 character description of the Jth air bag.
NPANEL(J)	Number of vehicle contact panels that are allowed to interact with the Jth air bag (maximum = 4).
Card D.4.b	FORMAT (6F12.0)
AB(I,J),I=1,3	The x, y and z semiaxes of the Jth air bag when fully inflated and undeformed (in).
BFA(I,J),I=1,3	The x, y and z coordinates of the center of the air bag contact ellipsoid with respect to the air bag center of gravity (in).
Card D.4.c	FORMAT (6F12.0)
YB,PB,RB	The initial orientation (yaw, pitch, and roll) of the Jth air bag in the vehicle reference (deg).
ZDEP(I,J),I=1,3	The x, y, and z coordinates of the deployment point of the Jth air bag in the local reference of the 1st panel on Card D.4.g (in).
Card D.4.d	FORMAT (6F12.0)
XBM(J)	Weight of air bag membrane and contents (lbs).
CYTD(J)	Gas supply actuator firing time after the start of vehicle deceleration (sec).
CYPA(J)	Atmospheric pressure (psia).
CYSP(J)	Initial gas supply pressure (psig).
CYT0(J)	Initial gas supply temperature (deg R).
CYV0(J)	Gas supply reservoir volume (in**3).

Card D.4.e	FORMAT (6F12.0)
CYCD(J)	Sonic throat discharge coefficient (dimensionless).
CYK(J)	Ratio of specific heats of supply gas (dimensionless).
CYR(J)	Specific gas constant (in/deg R).
CYAT(J)	Sonic throat area (in**2).
CYPV(J)	Vent pressure of the exhaust orifice (psig).
CYCD0(J)	Exhaust orifice discharge coefficient (dimensionless).
Card D.4.f	FORMAT (5F12.0)
CYA0(J)	Exhaust orifice area (in**2).
SPRK(J)	Spring constant of a linear spring used to simulate attachment of the bag at the deployment point in the vehicle (lb/in).
VSCS(J)	Coefficient of sliding friction of the air bag (dimensionless).
CK(J)	Parameter used to stabilize air bag numerical integration (sec**-1). Suggested value = 250.
CMASS(J)	Multiplier to increase or decrease the mass of the air bag to artificially dampen the integrated air bag motion.

NPANEL(J) sets of the following two cards are required to define the ellipsoids used to approximate the contact panels for the Jth air bag. The first panel is the reaction panel.

Card D.4.g FORMAT (6F12.0)

B(I,K,J),I=1,3	x, y, and z semiaxes for the Kth panel for the Jth air bag (in).
BFB(I,K,J),I=1,3	The location of the center of the panel ellipsoid with respect to its center of gravity (in).

Card D.4.h FORMAT (6F12.0)

ZR(I,K,J),I=1,3	x, y, and z coordinates in vehicle reference of the center of gravity of the Kth panel of the Jth air bag (in).
YP,PP,RP	Angular orientation, yaw,pitch and roll (deg), of the Kth panel with respect to the vehicle.

If NELP is nonzero on Card D.1, NELP D.5 Cards are required by Subroutine BINPUT.

Note: NELP is the number of contact ellipsoids to be supplied here, not the number of contact ellipsoids in the program. The first NSEG ellipsoids were supplied on Cards B.2.a - B.2.i with no angular rotations. They may be replaced here if desired.

Cards D.5.a - D.5.j (NELP cards)	FORMAT (I6, 9F6.0)
M	Contact ellipsoid number, max = 40. If M < NSEG + 1, data will replace input supplied on Cards B.2.a - B.2.i. Otherwise, M must be greater than MSEG+NBAG+1, where MSEG is either NSEG or largest MSEG from Cards C.2.a.
P1(I),I=1,3	The x, y, and z semiaxes of the contact ellipsoid (in).
P2(I),I=1,3	The x, y, and z coordinates of the ellipsoid offset from the segment center of gravity.
P3(I),I=1,3	The yaw, pitch and roll (degrees) of the contact ellipsoid from the local geometric axis of the segment.

If NQ is nonzero on Card D.1, NQ D.6 Cards are required.

Cards D.6.a - D.6.j (NQ cards)	FORMAT (3I6, 6F6.0)
KQTYPE(J)	Type No. of the Jth constraint. 1: Point specified by RK1 on segment KQ1 will be constrained to be the same as the point specified by RK2 on segment KQ2. 2: Point specified by RK1 on segment KQ1 will be constrained to remain at an equal distance (D > 0) from the point specified by RK2 on segment KQ2. 5: Tension element constraint connecting point RK1 on segment KQ1 to point RK2 on segment RK2 (requires two cards with KQTYPE, KQ1 and KQ2 the same on both).
KQ1(J)	Segment identification number of the 1st specified point.
KQ2(J)	Segment identification number of the 2nd specified point.
RK1(I,J),I=1,3	Coordinates of specified point on segment KQ1 (in). If KQTYPE = 5, the second card will contain the effective masses MA, MB and MAB (lb-sec**2/in) in place of RK1.
RK2(I,J),I=1,3	Coordinates of specified point on segment KQ2 (in). If KQTYPE = 5, the second card will contain the spring constant K (lb/in), the viscous damping constant D (lb-sec/in) and the reference length L (in) in place of RK2. Note: if KQTYPE = 1 and KQ2 is the number for the vehicle, then Subroutine EQUILB will modify these values of RK2 such that they will be equivalent to RK1 in inertial reference for time zero (see description under Cards G.6.).

Card D.7 is always required. Supply blank card for normal 3D motion.

Card D.7	FORMAT (18I4)	If NSEG>18, use 2 cards.

NSYM(J),J=1,NSEG — Controls symmetry option of body segments as follows :

NSYM(J) = 0 : Normal three dimensional motion for body segment J.

NSYM(J) = J : Motion of body segment J will be restricted to the x-z plane with no lateral motion, hence it will be two dimensional.

NSYM(J) = K : Body segments J and K are to remain symmetrical with no lateral motion. The motion of each will be replaced with their average and restricted to the local x-z plane. NSYM(K) must equal J.

NSYM(J) = -K : Body segments J and K are to remain mirror symmetrical with respect to the x-z plane. Equal but opposite lateral motion is permitted. NSYM(K) must equal -K.

Note : in the above symmetry options, the user must take extreme care that all input will allow the symmetry to exist.

If NSD is nonzero on Card D.1, NSD D.8 Cards are required.

Cards D.8.a - D.8.j (NSD cards) — FORMAT (2I3, 11F6.0)

MSDM(J) MSDN(J)	Segment identification numbers (M and N) to which the Jth spring damper is attached.
APSDM(I,J),I=1,3 APSDN(I,J),I=1,3	Coordinates of attachment points in local segment reference on segments M and N for the Jth spring damper (in)
ASD(I,J),I=1,5 I=1 : D0 (in) I=2 : A1 (lb/in) I=3 : A2 (lb/in**2) I=4 : B1 (lb-sec/in) I=5 : B2 (lb-sec**2/in**2)	Coefficients of quadratic functions to compute the spring force (FS) and the viscous force (FD) for the Jth spring damper using the relationships

```
FS= (D-D0)*(|A1| + A2*|D-D0|)
FD=     DV*( B1  + B2*|DV|)
```

where D and DV are the distance and its time deriative between the points APSDM and APSDN.

The following options are available:
(1) If A1<0 and (D-D0)<0, the program will set FS=0 and FD=0, i.e., this will act as a tension element.
(2) If D0<0 and (D-|D0|)>0 or A2=0
   a. If A1=0, program will set FS=0.
      If A1#0, A1 will be a function number (a positive real integer) to indicate that FD will be evaluated as a function of (D-|D0|) using function No. A1 defined on Cards E.
   b. If B1=0, program will set FD=0.
      If B1#0, FD will be computed as FS above by function No. B1.

If NFORCE is nonzero on Card D.1, NFORCE D.9 Cards are required.

Cards D.9.a - D.9.j (NFORCE cards)	FORMAT (3I4, 6F10.0) (Note: The 3I4 term was 2I6 prior to Version 21)
NFVSEG(J)	The identification number of the segment to which the Jth force function is to be applied. If NFVSEG(J) is negative, its magnitude is a joint number K at which a time-dependent torque can be applied. For this option, NFVNT(1,J) will be the number of a function defined on Cards E that defines torque (in-lbs) as a function of time (sec) and Y,P,R will define the direction of the torque. The torque will be applied positively to segment No. K+1 and negatively to segment No. JNT(K).
NFVNT(1,J)	The identification number of the function on Cards E that defines the force (lbs) as a function of time (sec). If supplied as a negative number, indicates to Subroutine WINDY that the STAPAC rocket option is being employed in which case NFVNT(2,J) is required.
NFVNT(2,J)	Required only if NFVNT(1,J) is negative. The identification number of the function on Cards E that defines the angular deviation (radians) from the nominal firing angle as a function of pitch rate (radians/sec).
X,Y,Z	The coordinates (in) of the point (local reference) on segment NFVSEG at which the force is to be applied.
Y,P,R	The yaw, pitch and roll (degrees) of a force coordinate reference system with respect to the local reference of segment NFVSEG. The force is applied in the direction of the plus x axis of this new reference system. For the STAPAC rocket option (NFVNT(1,J) negative), the y axis is the axis about which the pitch rate is measured, and the z axis represents the axis of the STAPAC gyro.

E. Subroutine CINPUT (functions input)

These functions are referred to by number in the NF arrays required on Cards F.1.b, F.2.b, F.3.b and F.4.b. They are used to define the force deflection, inertial spike, R (energy absorption) factor, G (deflection) factor and friction coefficient functions.

Each function may be subdivided, if desired, into two separate parts, F1 and F2, where

F1(D) is defined for D0 .LE. D .LE. |D1|.

F2(D) is defined for |D1| .LE. D .LE. |D2|.

In addition, each part of a function may be defined by either of three functional forms: constant value, tabular data or a fifth degree polynomial. The existence and form of each part is determined by the supplied values of D0, D1 and D2 as follows:

F1	F2	D0	D1	D2
--	--	--	--	--
Constant	-	0	0	F1 = D2
Tabular	-	D0 .GE. 0	D1 .LT. 0	0
Polynomial	-	D0 .GE. 0	D1 .GT. 0	0
Tabular	Polynomial	D0 .GE. 0	D1 .LT. 0	D2 .GT. 0
Polynomial	Tabular	D0 .GE. 0	D1 .GT. 0	D2 .LT. 0
Polynomial	Polynomial	D0 .GE. 0	D1 .GT. 0	D2 .GT. 0

The constant form is applicable to F1 only because the routines assume

if D .GT. |D2| then F(D) = F(|D2|) for D2 .NE. 0 or

if D .GT. |D1| then F(D) = F(|D1|) for D2 = 0.

The case of both F1 and F2 being tabular is unnecessary.

A maximum of 50 functions may be supplied to the program. These functions may be of the types described on either Cards E.1–E.4, Cards E.6 or Cards E.7.

Card E.1	FORMAT (I4, 4X, 5A4)
I	The function identifying number. These numbers need not be supplied in numeric order. If the same number is used more than once, a warning will be printed and the last one supplied will be used. The end of the function input is indicated by supplying a single card with I > 50.
KTITLE	A 20 character alphanumeric title describing the function.

Card E.2 FORMAT (5F12.0)

D0	The lower abscissa value of the first part (F1) of the function. Units are dependent on usage of the function, i.e., in for deflection, in/in for stress-strain, in/sec for rate dependent functions. Normally a value of zero is used for force deflection functions. A negative value may be supplied for rate dependent functions.
D1	The magnitude of D1 is the upper abscissa value of F1 and the lower abscissa value of F2, if any. D1 < 0 indicates F1 is tabular, D1 > 0 indicates F1 is a polynomial, and D1 = 0 indicates F1 = D2, a constant.
D2	If D1 = 0, D2 is the constant value of F1. Otherwise, the magnitude of D2 is the upper abscissa value of F2. If D2 = 0, F2 is not defined; if D2 is negative, F2 is tabular; and if D2 is positive, F2 is a polynomial.
D3	If the function is to be used for an inertial spike, D3 represents the abscissa value for which the inertial spike is to be ignored if unloading occurs after deflection exceeds D3. If the function is to be used for a coefficient of friction, D3 = (1+U)/2 where U is the coefficient of restitution for the impulse option (0<D3<1 or -1<U<+1). A value of D3 = 0 means that the impulse option will not be used for those contacts using this function. When the globalgraphic option is used, a friction function is defined and the value of D3 is used to specify the impulse. (See Card B.5.)
D4	If the function is to be used as a force deflection function by Subroutine PLELP, D4=RHO, the scalar that determines the point of force application. Supply zero for point of maximum penetration, one for center of intersection ellipse. If used as the friction function for a roll-slide constraint, D4 is the coefficient of static friction to be used for the roll constraint.

The definition of F1 and F2, if they exist, are now supplied on Card E.3 for the fifth degree polynomial definition, or on Cards E.4 for the tabular definition.

Card E.3	FORMAT (6F12.0)
A0,A1,A2,A3,A4,A5	Coefficients of fifth-degree polynomial F = A0 + A1*X + A2*X**2 + A3*X**3 + A4*X**4 + A5*X**5 (Units are dependent on use of function.)
Card E.4.a	FORMAT (I6)
NPI	The number of data points to be supplied to identify the function if it is defined in tabular form.
Cards E.4.b - E.4.n	FORMAT (6F12.0)
(X(I),Y(I),I=1,NPI)	The abscissa and ordinate values of the data points used to define the tabular form of the function. The program will linearly interpolate to determine intermediate values. Supply 3 points per card; Use as many cards as required. (Units are dependent on use of function.)

Note: Always supply a card E.1 with a function number > 50 after all functions are defined to signal the end of function inputs.

Subroutine KINPUT (wind force and joint restoring force functions)

Note: Card E.5, previously required for Version 12 (WPAFB Contract No. F33615-75-C-5002 as documented in report No. AMRL-TR-75-14) is no longer required. The variables NWINDF and NJNTF are now supplied on Card D.1.

If NWINDF=0 on Card D.1, Cards E.6 are not required. Otherwise, NWINDF sets of Cards E.6.a - E.6.n are required.

Card E.6.a	FORMAT (I4, 4X, 5A4)
I,KTITLE	Same as Card E.1 except that each function number (I) must be less than 51 and must be distinct from those supplied on Cards E.1.
Card E.6.b	FORMAT (5F12.0)
D0,D1,D2,D3,D4	Currently not used by program.
Card E.6.c	FORMAT (I6)
NTMPTS	The number of time points or cards required to define this function on cards E.6.d-E.6.n.
Cards E.6.d - E.6.n (NTMPTS CARDS)	FORMAT (4F12.0)
T	Time (sec) since initial penetration of boundary plane. Values should be in ascending order with first value equal to zero.
FX,FY,FZ	The x, y and z components of force per unit area (lbs/in**2) in inertial reference due to the wind blast force at time T. The program will use linear interpolation on T. If last value of T is exceeded, the last values of FX,FY and FZ will be used.

If NJNTF=0 on Card D.1, Cards E.7 are not required. Otherwise, NJNTF (from Card D.1) sets of Cards E.7.a - E.7.n are required.

Card E.7.a	FORMAT (I4, 4X, 5A4)
I,KTITLE	Same as Card E.1 except that each function number (I) must be less than 51 and must be distinct from those supplied on Cards E.1 or Cards E.6.a.
Card E.7.b	FORMAT (5F12.0)
D0,D1,D2,D3,D4	Currently not used by program.
Card E.7.c	FORMAT (2I6)
NTHETA	Magnitude indicates the number of columns in the two dimensional input data matrix to be supplied on Cards E.7.d-E.7.n. The minimum value is 2. If positive, the NTHETA entries in each row will be tabular data for equally spaced values of the joint flexure angle (THETA) between 0 and 180 degrees. If negative, the entries will represent the coefficients of a (-NTHETA-1) order polynomial in (THETA-THETA0).
NPHI	Number of rows of matrix of data to be supplied on Cards E.7.d-E.7.n. Each row represents equally spaced values of the joint azimuth angle (PHI) between -180 and +180 degrees, but does not include the last row since the program assumes data for PHI(NPHI+1)=180 are the same as for PHI(1)=-180. Minimum = 1.

Cards E.7.d - E.7.n FORMAT (5F12.0)
(NPHI sets of Cards. Use extra cards per set if !NTHETA! > 5.)

THETA0	The value of the "dead band" zone for this value of PHI (degrees). If the flexure angle (THETA) is less than THETA0, the joint restoring force will be zero.
F(J),J=2,NTHETA	For NTHETA positive, tabular values of the joint restoring force for flexure angles THETA(J) = (J-1)*180/(NTHETA-1) degrees values of zero should be supplied for THETA < THETA0. For NTHETA negative, the coefficients of a polynomial in (THETA-THETA0) of order one less than the magnitude of NTHETA. F(J) is the coefficient of (THETA-THETA0)**(J-1) where (THETA-THETA0) is expressed in radians. F(1) is assumed to be zero.

F. Subroutine FINPUT (allowed contacts)

If NPL is nonzero on Card D.1, Cards F.1 are required.

Card F.1.a	FORMAT (18I4)	If NPL>18, use 2 cards.

MNPL(J),J=1,NPL — For plane J, the number of segments for which segment-plane contact is allowed. NPL is the number of planes from Card D.1. The value of any MNPL for plane J may be zero and the maximum value is 5. However if it is required to have more than 5 segments contact the same plane, set up two or more identical planes and permit a maximum of 5 segments to contact each plane.

For each plane J, MNPL(J) cards of the following must be supplied.

Cards F.1.b - F.1.n	FORMAT (9I4)

NJ — The plane number for which contact is allowed. NJ must correspond to J above. There must be MNPL(J) cards with this same NJ. If MNPL(J) = 0, no NJ = J should be present.

NS(1) — The segment number to which plane J is attached. If vehicle, supply MSEG+1, if ground, supply MSEG+NBAG+2, where MSEG is either NSEG or largest MSEG from Cards C.2.a.

NS(2) — The segment number (determined by the Card Number I under Card B.2.a) for which contact with the NJth plane is allowed.

NS(3) — The number of the contact ellipsoid associated with the segment NS(2). If negative, the contact location printed in the tabular time history for this contact will be in the local reference coordinate system for segment NS(2), if positive for segment NS(1).

NF(1)	The function No. from Card E.1 to define the force deflection function for this contact. If NF(1)=0, a roll-slide constraint will be exercised by the program for this contact which does not require NF(2),NF(3) or NF(4) but does require a friction coefficient function to be defined by NF(5). Also, the initial positions on Cards G.2 must be such that there is no contact at time = 0.
NF(2)	The function No. from Card F.1 to define the inertial spike function for this contact. If zero or negative, no inertial spike exists. If negative, the magnitude specifies the function No. for F2 of the rate dependent functions described below.
NF(3)	The function No. from Card E.1 to define the R (energy absorption) factor function. A value of R=1 indicates that all energy is recovered (no loss) and R=0 that no energy is recovered. If zero, R=1 is assumed (default). If negative, the magnitude specifies the function No. for F3 of the rate dependent function described below.
NF(4)	The function No. from Card E.1 to define the G (permanent deflection) factor function. If zero, G=0 is assumed (default). If negative, the magnitude specifies the function No. for F4 of the rate dependent functions described below.
NF(5)	The function No. from Card E.1 to define the friction coefficient function. If for a roll-slide constraint (NF(1)=0), the value of D3 on Card E.2 for this function should be 0.5.

Note: Rate dependent functions can be used instead of the inertial spike, R and G factors by defining NF(2), NF(3) and NF(4) all zero or negative. The total force deflection function is computed by

$$F(D,D') = F1(D) + F2(D)*F3(D') + F4(D')$$

Where D and D' are the deflection and rate of deflection; and F1,F2, F3 and F4 are functions specified by NF(1),NF(2),NF(3) and NF(4). If NF(2),NF(3) or NF(4) is zero, the corresponding function is zero. If D<0, the rate dependent functions are not computed and F(D,D')=0. The functions should be defined such that F1(D), F2(D), D'*F3(D') and D'*F4(D') are all greater than or equal to zero. Hence, F(D,D') may be negative if D' is negative.

If NBLT is nonzero on Card D.1, Cards F.2 are required.

Card F.2.a FORMAT (8I4)

MNBLT(J),J=1,NBLT	For belt J, the number of segments for which segment-belt interaction is allowed. NBLT is the number of belts from Card D.1. Each MNBLT may have a value of 0 or 1 only.

For each belt J, MNBLT(J) cards of the following must be supplied.

Cards F.2.b - F.2.n FORMAT (9I4)

NJ	The belt number to be contacted, must correspond to J above. There must be MNBLT(J) cards with the same NJ. If MNBLT(J) = 0, no NJ = J should be present.
NS(1)	The segment number to which belt NJ is attached. If vehicle, supply MSEG+1, if ground, supply MSEG+NBAG+2, where MSEG is either NSEG or largest MSEG from Cards C.2.a.
NS(2)	The segment number (determined by the card number I under Card B.2.a) for which interaction with the NJth belt is allowed.
NS(3)	The number of the contact ellipsoid associated with the segment NS(2).
NF(1)	The function number from Card E.1 to define the force-deflection function for this contact. The abscissa for this function should be strain (in/in).
NF(I),I=2,4	Same definition as on Card F.1.b above.
NF(5)	If nonzero, full belt friction is assumed, i.e., forces are computed for each half of the belt separately. If zero, zero belt friction is assumed, i.e., belt tension is the same at both belt anchor points.

Note: The use of rate dependent functions as defined under Cards F.1.b are not currently operational for belt-segment contacts.

Card F.3.a is always required. May be blank to specify that no segment-segments are to be computed by the program.

Card F.3.a		FORMAT (18I4) If NSEG>18, use two cards.
	MNSEG(J),J=1,NSEG	For segment J, the number of segments for which segment-segment contact is allowed. NSEG is the number of segments from Card B.1. each segment contact, A versus B, may be inputted either way except where an interior contact is desired (see NS(3)). Any or all values of MNSEG may be zero. The maximum value for each MNSEG is 5.

For each segment J, MNSEG(J) cards of the following must be supplied.

Cards F.3.b - F.3.n		FORMAT (9I4)
	NJ	The segment number to be contacted, must correspond to J above. There must be MNSEG(J) Cards with this same NJ. If MNSEG(J) = 0, no NJ = J should be present.
	NS(1)	The number of the contact ellipsoid associated with segment NJ.
	NS(2)	The segment number (determined by the Card number I under Card B.2.a) for which contact with the NJth segment is allowed.
	NS(3)	The number of the contact ellipsoid associated with the segment NS(2). If negative, an interior contact will be assumed with ellipsoid NS(1) inside NS(3).
	NF(I),I=1,5	Same definitions as on Card F.1.b above.

Note: The use of rate dependent functions as defined under cards F.1.b are permissable for segment-segment contacts.

If NJNT is nonzero on Card B.1, Card F.4.a is required.
Supply IGLOB=1 for globalgraphic option, otherwise supply 0 or blank.

Card F.4.a — FORMAT (18I4) If NJNT>18, use two cards.

IGLOB(J),J=1,NJNT — For each joint J, supply 1 for IGLOB(J) if IPIN(J) is +3 or -3 on Cards B.3.a - B.3.j; otherwise supply zero or blank. One card F.4.j must be supplied below for each J for which IGLOB(J) =1.

Cards F.4.b - F.4.j — FORMAT (9I4)

NJ — The identification number for a globalgraphic joint, must correspond to J above and Cards must be supplied in ascending order on NJ.

NS(I),I=1,3 — Currently not used by program.

NF(1) — The function number from Card E.1 to define the torque-deflection for this globalgraphic joint. The ordinate for this function should be torque (in-lb) and the abscissa is the angular deflection (radians) into the stop.

NF(2) — The function number from Card E.1 to define the Herron formulas for T (joint stop angle in radians) and its derivative TP with respect to PHI both as functions of PHI (the joint angle from the reference axis in radians). Normally they will be computed by

T = P1 + SP*P2
TP = P1' + CP*P2 + SP*P2'

Where P1,P2 are the 5th degree polynomial evaluations of COS(PHI) using the two polynomials F1 and F2 obtained by setting both D1,D2 > 0 on card E.2;

P1',P2' are their derivatives with respect to PHI;

and CP,SP are COS(PHI) and SIN(PHI).

If D1,D2 are not both positive, T and TP will be evaluated as functions of PHI in radians (0 < PHI < 2*PI) as specified on Cards E.1 - E.4 for function NF(2).

NF(I),I=3,5 — Same definitions as on Card F.1.b above except that the use of rate dependent functions is not permitted.

If NJNT>0 (Card B.1) and NJNTF>0 (Card D.1), Card F.5.a. is required. If NJNT>0 and NJNTF=0, the program will set the JOINTF array to zero and Card F.5.a is not required (Note: for Version 12 a blank card was required).

Card F.5.a		FORMAT (18I4) use two cards if NJNT > 18.
	JOINTF(J),J=1,NJNT	For each joint (J), the function identification number as supplied on Cards E.7.a to be used by Subroutine VISPR to compute the joint restoring force by function FNTERP. If zero, the values of SPRING(1,3*J-2) as supplied on Cards B.4.a will be used using function EJOINT.

If NBAG ≠ 0, NBAG Cards of the following must be supplied. Since the air bag routines do not use the force-deflection functions, this input has different formats than the above allowed contacts.

Cards F.6.a - F.6.n		FORMAT (2I4, 20I2)
	K	The air bag number corresponding to the index J under Cards D.4 above. K must be in numeric order K = 1 to NBAG, where NBAG is the number of air bags defined on Card D.1.
	NK	The number of segments allowed to contact the Kth air bag. The maximum value is 10. If NK=0, the remainder of the card is blank.
	MBAG(2,I,K), MBAG(3,I,K),I=1,NK	The segment numbers (determined by the card number I under Card B.2.a) each followed by the number of the associated contact ellipsoid for which contact forces with the Kth air bag will be computed.

If NWINDF=0 on Card D.1, Cards F.7 are not required and the program will set the MWSEG array to zeros (Note: for Version 12 a blank card F.7.a was previously required). Otherwise, Cards F.7 are required.

Card F.7.a FORMAT (18I4) use two cards if NSEG > 18.

MWSEG(1,J),J=1,NSEG	For each segment J, supply zero if no wind force calculations are to be performed. Supply a value of one to indicate wind forces are to be computed by Subroutine WINDY. Supply a value of -1 to indicate aerodynamic forces and torques are to be computed by Subroutine AIRFLW for segment No. J.

Supply Card F.7.b for each segment (J) where MWSEG(1,J) = 1.

Card F.7.b FORMAT (5I4)

JJ	The segment identification number from cards B.2.a for which wind force calculations are to be performed. Must correspond to J from Card F.7.a and be supplied in ascending order.
MWSEG(2,J)	The number of the contact ellipsoid to be associated with segment number JJ.
MWSEG(3,J)	The segment identification number (MSEG+1 for the vehicle, MSEG+2 for the ground, where MSEG is either NSEG or largest MSEG from Cards C.2.a) associated with plane number MWSEG (4,J).
MWSEG(4,J)	The plane identification number from card D.2.a through which if segment J passes, wind force calculations will be performed.
MWSEG(5,J)	The function number from Card E.6.a for the wind force function to be used.

F.8 Subroutine HINPUT - Card input for harness-belt systems.

Note: NHRNSS which was supplied on Card F.8.a for Version 12 is now supplied on Card D.1. If NHRNSS#0, Cards F.8 must be supplied. Previously for Version 12, a blank Card F.8.a was required if no harness belt systems were desired.

Card F.8.a	FORMAT (5I4)
NBLTPH(I), I=1,NHRNSS	Number of individual belts for each harness No. I. May be zero or blank. Maximum value of sum of all NBLTPH is 20.

Card F.8.a is followed by NHRNSS sets of Cards F.8.b - F.8.d.

Card F.8.b	FORMAT (18I4) use two cards if NBLTPH(I)>18.
NPTSPB(J), J=1,NBLTPH(I)	The number of reference points including anchor points for belt No. J of harness No. I. May be zero or blank. The maximum value of the sum of all NPTSPB for all harness-belt systems is 100. The maximum value of the sum of all NPTSPB for any one harness belt system is 50. The maximum value of any individual NPTSPB is 25.

Each Card F.8.b is followed by NBLTPH(I) sets of Cards F.8.c - F.8.d.

Card F.8.c	FORMAT (5I4, F12.0)
NF(L),L=1,5	The function numbers from Cards E.1 to define the stress-strain of belt No. J. The definition of these functions are identical to those of NF(1) to NF(4) on Cards F.2.b, except that the use of rate dependent functions is permitted. NF(5) is not currently used by the program.
XLONG(J)	The initial slack (in) of belt No. J. A negative value can be specified to indicate a pre-tightened belt. The program will add this to the initial geometric length to obtain the initial belt length and distribute the slack proportionately between the points.

Each Card F.8.c is followed by NPTSPB(J) pairs of F.8.d1 and d2 Cards to specify the reference points (K) for belt (J) of harness (I).

Card F.8.d1 FORMAT (9I4, 3F12.0)

KS	Integer of the form 100*KTP*KSEG, where KSEG is the identification number of the segment associated with reference point (K), and KTP is a tie-point identification number which may be blank or zero. All points (K) of harness (I) that have the same nonzero value for KTP (there should be only one for each belt (J)) will be connected and should have identical values for all other input.
KE	The identification number of the contact ellipsoid associated with reference point No. K. If no ellipsoid is specified (KE=0), the program will assume a unit sphere.
NPD	Indicator for the preferred direction option. If a nonzero integer is given, a nonzero vector must be specified for BAR(L,K),L=10,12 on Card F.8.d2. The reference points will be allowed to move along the surface in a direction which is perpendicular both to this vector and to the normal of the surface subject to the constraint imposed by D2 of function NF(5) below. If NPD=0, the nominal belt line is used in place of this vector. NPD must be nonzero if point No. K is a tie point.
NDR	Indicator for the delta R option. If NDR = 0, belt (j) will be allowed to slip at reference point (K). If NDR ≠ 0, belt (J) will not slip but reference point (K) will be moved along the nominal belt line. In both cases the slippage or motion is subject to the constraint imposed by the coefficient of friction given by D4 of function NF(5) below. NDR must be nonzero for end reference points of the belt.
NF(L),L=1,4	The function numbers from Cards E.1 to define the force deflection function between belt (J) and reference point (K). If NF(1) = 0, the surface is treated as rigid and no perturbation of the reference point normal to the surface is allowed. The use of rate dependent functions as defined under Cards F.1.b is permitted.

NF(5) — The function number from Card E.1 to define the friction coeffi-ients for belt (J) at reference point (K). Two cc..straint values are to be defined on Card E.2 of this function by setting D0 = D1 = D3 = 0. D2 is the coefficient of friction perpendicular to the nominal belt line along the surface and D4 is the coefficient of friction along the nominal belt line. If NF(5) = 0, infinite friction is assumed.

BAR(L,K),L=1,3 — The x, y, and z coordinates (in) of reference point (K) of belt (J) in the local coordinate system of segment No. KS. if an ellipsoid is specified (KE≠0), the point is referred to the center of the ellipsoid and the supplied values will be adjusted by the program to lie on the ellipsoid surface. If KE = 0, a nonzero vector must be specified. This vector will be used to compute the normal in the definition of its local coordinate system and to resolve the belt forces. The program will assume that belt (J) will run through the points in the specified order. However, if the forces are such as to pull the belt away from the surface, this point will be ignored if it is not an end or attachment point.

Card F.8.d2 — FORMAT (6F12.0)

BAR(L,K),L=7,9 — The x, y and z coordinates (in) of the offset in the local coordinate system of segment KS. This vector is added to the reference vector defined above (L=1,3) to determine the location of the reference point (K) relative to the c.g. of segment KS.

BAR(L,K),L=10,12 — The x, y and z coordinates of a vector in the local coordinate system of segment KS. This vector is used for the preferred direction (see NPD above). This vector must not be parallel to the normal computed from BAR(L,K), for L=1,3 above.

G. Subroutine INITIAL

Card G.1.a FORMAT (3F10.0, 5I4)

ZPLT(I),I=1,3	The x, y and z plot coordinates (for Subroutine PRIPLT) of the origin of the vehicle reference system. $0 < x < 61$ $0 < y < 61$ $0 < z < 121$
I1	A value of 15 is required to call Subroutine EQUILB and process Cards G.4, G.5 and G.6.
J1	If nonzero, Card G.1.b is required to define scaling information for the printer plots.
I2,J2	Currently not used by the program.
I3	If zero, segment and angular velocities are not supplied on the following cards but are set equal to the initial vehicle velocity. If I3 ≠ 0, SEGLV and WMGDEG must be supplied.

If J1 is zero or blank on Card G.1.a, the following Card G.1.b should not be supplied and default values of 10.0, 6.0 and 1.0 will be used for the SPLT array.

Card G.1.b FORMAT (3F10.0)

SPLT(1)	The number of horizontal print positions per unit length for the output unit that will print the printer plots produced by Subroutine PRIPLT (normal value is 10.0 for 10 spaces or columns per inch).
SPLT(2)	The number of vertical print lines per unit length (normal values are 6.0 or 8.0 for 6 or 8 lines per inch). The program uses only the ratio of SPLT(1) to SPLT(2).
SPLT(3)	Scale factor that represents the distance (inches or length unit on Card A.3) between vertical print lines for the printer plots. Note: the printer plot was originally designed for 120x60 units (inches) along the z and x or y directions which may not be satisfactory for certain situations (e.g., metric units).

One G.2 Card must be supplied for each reference segment (i.e., segment No. 1 and for each segment J+1 where JNT(J) = 0 on Cards B.3) in ascending segment number sequence.

Cards G.2.a - G.2.m	FORMAT (6F10.0)
SEGLP(I,J),I=1,3	The initial x, y and z coordinates of the Jth body segment in inertial reference (in).
SEGLV(I,J),I=1,3	The initial x, y and z components of velocity of the Jth body segment in inertial reference (in/sec). These fields may be left blank if I3 = 0 on Card G.1 in which case the initial velocity of the vehicle will be used.
Cards G.3.a1-G.3.n1 (NSEG Cards or sets of	FORMAT (6F10.0, 4I3) G.3.j1, G.3.j2 Cards)
YPR(I,J),I=1,3	The initial rotation angles (degrees) of the Jth segment about its local z, y and x axes with respect to the segment given by ID(4,J) in the order specified by ID(I,J),I=1,3 below.
WMGDEG(I,J),I=1,3	The initial components of angular velocity about the local x, y and z axes of the Jth body segment (deg/sec). If I3 = 0 on Card G.1, the initial angular velocity of the vehicle will be converted to the segment reference and will be used.
ID(I,J),I=1,3	Indicators used to specify the order of the axes of the rotations given in YPR above. (See complete definition under Cards B.3.a2.) Zeros or blanks will default to 1,2 and 3 to indicate that the standard sequence of yaw, pitch and roll is reversed (as required by Versions previous to 18A of the program).
	Values of 3,2,1 indicates that the standard yaw, pitch and roll sequence be used.
	Values of 3,1,-3 indicates that precession, nutation and spin for euler joints be used.
	A negative value for ID(1,J) indicates that projections or projection angles of the principal axes of segment J will be used and that a Card G.3.j2 will follow this card.

ID(4,J) The segment number to which the rotations given by YPR or by angles on Card G.3.j2 are respect to. A value of zero or blank will default to the ground (MSEG+NBAG+2) or inertial reference. The vehicle may be specified by supplying MSEG+1, where MSEG is either NSEG or largest MSEG from Cards C.2.a. Otherwise the No. of the segment must be less than J. A negative number (-|JNT(J-1)|, as specified on Card B.3.a1) may be used to define the rotation angles with respect to the joint principal axes as specified on Card B.3.a2.

Note: The values of YPR and ID are used to compute a direction cosine matrix R. The direction cosine matrix D(J) of segment J is determined by the value of K = ID(4,J) as follows:

K = 0: D(J) = R(J)	(K=0 or equal to NGRND)
K > 0: D(J) = R(J)D(K)	(K<J or equal to NVEH)
K < 0: D(J) = H'(J)R(J)H(K)D(K)	(K = -|JNT(J-1)|)

There are no restrictions on a ball or Euler joint. An Euler joint can be set to an initial precession(P), nutation(N) and spin(S) by specifying YPR = P,N,S and ID = 3,1,-3,-|JNT(J-1)|. To preserve the axes of a pin joint, care must be taken that the relative orientation of segments J and JNT(J-1) represents a rotation about the pin axis only. (The pin axis is always the y axis of the joint principal axes as specified on Card B.3.a2.) This can be assured by supplying YPR = 0,P,0 and ID = 0,0,0,-|JNT(J-1)| where P is the pitch of segment J with respect to the center of symmetry (Card B.3.a2) of joint J-1. For the case where the y axes of segments J and JNT(J-1) are parallel to the pin axis, the pin axis can be preserved by supplying values of YPR = 0,P,0 and ID = 0,0,0,+|JNT(J-1)| where P is the pitch of segment J with respect to segment JNT(J-1).

A Card G.3.j2 must follow any Card G.3.j1 on which ID(1,J) is negative.

Cards G.3.a2-G.3.n2 FORMAT (6F10.0, 4I3)

A1,A2,A3	Specifies the projection of the primary axis given by IK below. If II is negative, values will be the x, y and z components (in) in the projection reference system of a vector along the positive IK axis of segment No. J. if II is positive, A1,A2 (A3 not used) are the projection angles (deg) of the positive IK axis of segment number J in two of the projection reference planes specified by the value of II.
B1,B2,B3	Specifies the projection of a secondary axis given by JK below. Definition is identical to A1,A2,A3 above but uses JJ and JK instead of II and IK.
II	If II is negative, the components of a vector along the positive IK axis will be given by A1, A2,A3. If II is positive, a value of 1,2 or 3 is used to indicate that the x, y or z axis is the common axis of the two projection reference planes used to specify the two projection angles as follows: If II=1, A1 in z-x plane, A2 in x-y plane. If II=2, A1 in x-y plane, A2 in y-z plane. If II=3, A1 in y-z plane, A2 in z-x plane. In the x-y plane, the angle is measured from the x-axis, positive toward the y axis. In the y-z plane, the angle is measured from the y-axis, positive toward the z axis. In the z-x plane, the angle is measured from the z axis, positive toward the x axis. Restriction: Sin(A1) * Cos(A2) cannot be zero.
IK	A value of 1,2 or 3 to specify that the x, y or z axis of segment number J is the primary axis to be projected.
JJ,JK	Same definition as for II,IK above but for a secondary axis of segment number J. The value of JK must be different than that of IK.

Subroutine EQUILB

Cards G.4, G.5 and G.6 are required if I1 = 15 on Card G.1.

Card G.4	FORMAT (2I4)
NVAR	No. of independent variables supplied on Cards G.2 and G.3 that are to be adjusted such that contact normal forces are equal to either GX supplied on Cards G.5 or constraint normal forces controlled by Cards G.6 (Max = 10).
NCON	No. of constraints to be imposed to compute those constraint forces which will be satisfied by initial contact forces. If zero, the supplied values of GX will be used. (Max = 5)
Cards G.5.a - G.5.n (NVAR Cards)	FORMAT (3I4, 2F8.0, 8I4)
NTV(J)	Indicates type of Jth independent variable 1 - SEGLP from Cards G.2 2 - YPR from Cards G.3
NI1(J)	A value of 1,2 or 3 to indicate the x, y or z coordinate of SEGLP if NTV(J)=1, or yaw, pitch or roll of YPR if NTV(J)=2.
NSG(J)	The segment number (as specified by index I of Cards B.2) for the Jth independent variable.
GX(J)	The magnitude of the contact normal force for the Jth independent variable (lbs). If this contact is to be controlled by a constraint on Cards G.6 (i.e., J=INDGX(I)), the supplied value of GX will be the initial value for the iteration of the contact normal force to equal the constraint normal force; otherwise, the Jth independent variable will be adjusted such that the contact normal force will be equal to GX.
XDEV(J)	The maximum allowable deviation from the initial positions specified on Cards G.2 and G.3 during the iteration of the Jth independent variable for the contact normal force to equal GX. If exceeded, the program will terminate with an error message. If XDEV = 0, the tests will not be performed.

JPL(J)	The plane number corresponding to NJ on Cards F.1.b - F.1.n for the contact whose normal force is to be controlled by the Jth variable.
JSG(J)	The segment identification number (as specified by index I of Cards B.2) involved in the contact with plane No. JPL(J). Note: a contact for this plane and segment must have been set up on Cards F.1.b - F.1.n.
NAV(J)	No. of variables associated with the Jth independent variable. (Max= 5, may be zero)
KSG(I,J),I=1,NAV	The segment numbers (definition same as for NSG(J)) for the NAV(J) variables associated with the Jth independent variable. Any change made to the Jth independent variable to achieve initial equilibrium will also be made to the corresponding variables for these segments such that the initial relative orientation will be maintained as specified on Cards G.2 and G.3.

Cards G.6.a - G.6.m (NCON Cards)	FORMAT (4I4)
IPL(I),ISG(I)	The plane and segment numbers (definition same as for JPL(J) and JSG(J) above) for the Ith constraint to be imposed for initial equilibrium during the contact normal force to constraint normal force iteration.
LTYPE(I)	Indicates the type of the Ith constraint 3 - Roll constraint 4 - Slide constraint
INDGX(I)	The index J (from 1 to NVAR) from Card G.5 for whose contact normal force will be iterated to be equal to the Ith constraint normal force. May be zero, but if INDGX(I) = J, then IPL(I) and ISG(I) must be equal to JPL(J) and JSG(J).

Note: Subroutine EQUILB will adjust the initial position parameters supplied on Cards G.2 and G.3. If the constraints temporarily imposed by Cards G.6 properly constrain all of the segments, zero accelerations will be obtained while the constraints are on. The iteration will produce normal and tangential contact forces that will result in small (< 0.02 G) initial linear accelerations for all of the body segments. For the seated "standard" fifteen segment occupant, this can be achieved as follows:

A. Lock joint P, W, NP, HP, RA and LA by setting IPIN = -2 on Cards B.3. If the maximum torque for a locked joint (T1 for VISC(4,3*J-2) on Cards B.5) is zero, then Subroutine EQUILB will set T1 for these locked joints to 1.5 times the magnitude of the joint torque finally produced at time zero.

B. Constrain the arms by either setting up fixed point constraints (type=1) for the RLA and LLA with the vehicle on Cards D.6, or lock the joints RS, RE, LS and LE as in step A above. If the constraints are imposed on Cards D.6, Subroutine EQUILB will adjust the point on the vehicle (RK2 on Cards D.6) for any type 1 constraint involving the vehicle so that it will coincide with the specified point on the body segment (RK1 on Cards D.6) as adjustments are made to the initial position parameters.

C. Set up allowed contacts and associated force deflection functions on Cards F.1 for the seat cushion plane with the LT, RUL and LUL segments, the seat back plane with the LT, CT and UT segments, and the floorboard plane with the RF and LF segments.

D. Set up initial position parameters on Cards G.2 and G.3 that are just "short of" or close to the final penetration distances for the segments with the contact planes.

E. Set NVAR = 5 and NCON = 4 on Cards G.5:

F. Supply the following input parameters on Cards G.5:

J	NTV	NI1	NSG	GX	XDEV	JPL	JSG	NAV	KSG
1	1	3	(LT)	90.0	1.0	(seat cushion)	(LT)	0	
2	1	1	(LT)	5.0	1.0	(seat back)	(LT)	0	
3	2	2	(UT)	10.0	5.0	(seat back)	(UT)	4	(LT),(CT),(N),(H)
4	2	2	(RUL)	25.0	10.0	(seat cushion)	(RUL)	1	(LUL)
5	2	2	(RLL)	10.0	10.0	(floorboard)	(RF)	1	(LLL)

G. Supply the following input parameters on Cards G.6:

I	IPL	ISG	LTYPE	INDGX
1	(seat cushion)	(LT)	3	1
2	(seat back)	(UT)	4	3
3	(floorboard)	(RF)	3	5
4	(floorboard)	(LF)	3	0

Using the above input parameters, Subroutine EQUILB will adjust the x and z coordinates of the LT, the pitch angles (maintaining the initial relative orientation) of the UT, LT, CT, N and H segments, the RUL and LUL segments, and the RLL and LLL segments, and the initial normal contact forces (GX) of the seat cushion with the LT, the seat back with the UT and the floorboard with the RF. It is believed that the resulting initial positions are unique and are functions of the values of the contact normal forces (GX) supplied for the seat back with the LT and the seat cushion with the RUL contacts.

H. Subroutine OUTPUT

This Subroutine provides input to control the desired time history output of selected segment linear and angular accelerations, velocities, and displacements, and joint parameters.

H.1 (K=1) Segment linear accelerations in local reference

Card H.1.a FORMAT (2I6, 3F12.6)

NSG(K)	The number of selected points on the various body segments for which time histories are desired. The maximum value for NSG(K) is 20. If NSG(K) is 0, insert 2 blank cards. If NSG(K) is 1, a single blank card should follow card H.1.k.
MSG(1,K)	The segment number of the first point as determined by the index I on Cards B.2.a - B.2.n. The vehicle may be specified by MSEG+1, or the Jth airbag by MSEG+1+J, where MSEG is either NSEG or largest MSEG from Cards C.2.a.
XSG(I,1,K),I=1,3	The x, y, and z coordinates in segment reference of the first point (inches).

Followed by NSG(K)-1 Cards of the following (J = 2, NSG(K))

Cards H.1.b - H.1.n FORMAT (I12, 3F12.6)

MSG(J,K)	Same as above but for the Jth point.
XSG(I,J,K),I=1,3	Same as above but for the Jth point.

H.2 (K=2) Segment linear velocities in vehicle reference

Cards H.2.a - H.2.n FORMAT (2I6, 3F12.6/ (I12, 3F12.6))

Description same as for H.1

H.3 (K=3) Segment linear displacements in vehicle reference

Cards H.3.a - H.3.n FORMAT (2I6, 3F12.6/ (I12, 3F12.6))

Description same as for H.1

H.4 (K=4) Segment angular accelerations in local reference

Card H.4	FORMAT (12I6/ (I12, 10I6))
NSG(K)	The number of selected segments for which time histories are desired (Maximum = 20). Supply blank card if none are desired.
MSG(J,K),J=1,KSG where KSG=NSG(K)	The segment numbers as determined by index I on Cards B.2.a - B.2.n. The vehicle may be specified by MSEG+1, or the Jth airbag by MSEG+1+J, where MSEG is either NSEG or largest MSEG from Cards C.2.a. If NSG(K) > 11, use the second card, leaving the first field of 6 columns blank. If NSG(K) = 11, a second card, completely blank, should follow this card.

H.5 (K=5) Segment angular velocities in vehicle reference

Card H.5 FORMAT (12I6/ (I12, 10I6)

Description same as for H.4.

H.6 (K=6) Segment angular displacements in vehicle reference

Card H.6 FORMAT (12I6/ (I12, 10I6))

Description same as for H.4.

H.7 (K=7) Joint Parameters

Card H.7	FORMAT (12I6/ (I12, 10I6))
NSG(K)	The number of selected joints for which time histories are desired. Insert blank card if none are desired (NJNT Maximum).
MSG(J,K),J=1,KSG where KSG=NSG(K)	The joint numbers as determined by index J on Cards B.3.a - B.3.j. If NSG(K) > 11, use a second card leaving the first field of 6 columns blank. If NSG(K) = 11, a second card, completely blank, should follow this card.

H.8 Complete Body Properties *
(Note: these H.8 Cards are new as of Version 21. Any previous input *
decks will require a blank card at this point in the input deck to be *
compatible with the new Version 21 input requirements.) *
*

Card H.8 FORMAT (I6) *
*

MCG	The number of bodies (collection of segments) for which time histories are desired (Max = 5). Each time history will contain the center of gravity and the total linear and angular momentum of the set of segments specified. If zero or blank, no Cards H.8.a are required.	*

Cards H.8.a - H.8.j FORMAT (24I3) *
(MCG cards) *
*

MCGR(J)	The identification No. of the segment to which the center of gravity is referenced.	*
MCGN(J)	The number of segments in the set of segments for the Jth tabular time history of body properties.	*
MCGS(I,J),I=1,MCGN	The identification Nos. of the MCGN segments that are to be included in the Jth set of segments.	*

H.9 (Subroutine POSTPR) - HIC, HSI and CSI calculations.
(Note: prior to Version 21, these cards were identified as Cards H.8.) ¦
This card is required whenever Subroutine POSTPR is called as determined by the value of NPRT(4) on Card A.5 (all values but 0 or 4).

Card H.8 FORMAT (18I4)

JDTPTS(1)	The index J on Cards H.1 corresponding to the head c.g. whose resultant acceleration time history will be used to compute the head injury criteria (HIC) and head severity index (HSI). The computations will not be done if JDTPTS(1) = 0 or blank.
JDTPTS(2)	The index J on Cards H.1 corresponding to the point whose resultant acceleration time history will be used to compute the chest severity index (CSI). The computations will not be done if JDTPTS(2) = 0 or blank.

I. Subroutine POSTPR

Cards I are required only if NPRT(4) is an odd integer on Card A.5. (See note in Subroutine SLPLOT regarding program changes that may be necessary on plotting facilities other than those at Calspan.)

These cards essentially specify all of the arguments to Subroutine SLPLOT and the indicees of the data in the tabular time histories to be plotted. The ability exists to plot any set of variables in the time histories as a function of any other variable on a fixed (specified by the user input) x-y axis. Both axes may be either linear or logarithmic. Any data falling outside of the specified range of each axis will be ignored. The input also specifies the x and y axis labels and two lines of plot identification that lies below the x axis label.

Card I.1 FORMAT (18I4)

NPLT	The number of plots to be generated (Max=20). (If NPLT > 17, use two cards.)
NYP(K),K=1,NPLT	The number of Y variables to be plotted vs. the same X variable for each of the NPLT plots. NPLT + sum of NYP is limited to 25.

A set of Cards I.2-I.8 is required for each of the NPLT plots.

Card I.2.k FORMAT (18I4)

MX1(K),MX2(K)	The page No. (MX1) and column No. (MX2) from the tabulated time histories of the X (horizontal) variable for the Kth plot. These page Nos. start with 21 so MX1 > 20. MX2 = 0 refers to time (msec), the leftmost column. MX2 can be supplied as a negative integer to indicate that the value for time zero will be subtracted from all values for plotting purposes.
MY1(J,K),MY2(J,K) for J=1,NYP(K)	The page No. (MY1) and column No. (MY2) for the NYP(K) Y (vertical) variables to be plotted vs. the X variable specified by MX1 and MX2 for the Kth plot. Definition of each MY1,MY2 same as for MX1,MX2 above.

Card I.3.k FORMAT (I4, 4X, 4F810)

NX(K)	The number of intervals or plotting decrements along the X (horizontal) axis for the Kth plot. There will be NX(K)+1 tic marks and numeric annotations, the first will be for X0(K) and the last for XN(K). If NX(K) is positive, the scale will be linear, and if negative, the scale will be logarithmic.
X0(K)	The value of the origin of the x axis for the Kth plot.
XN(K)	The value of the end of the x axis for the Kth plot. For NX(K) positive, XN(K) should equal X0(K) + NX(K)*DX, where DX is a reasonable plot decrement. If NX(K) is negative, both X0(K) and XN(K) should be powers of ten, where XN(K) = X0(K)*10**|NX(K)|.
XL(K)	The length (plotting inches) of the x axis for the Kth plot. XL(K) should be at least one inch less than XS(K).
XS(K)	The paper size (plotting inches) in the x direction for the Kth plot. The plot will be centered within this dimension.

Card I.4.k FORMAT (I4, 4X, 4F8.0)

NY(K),Y0(K),YN(K), YL(K) and YS(K)	Same definitions as for the corresponding items on Card I.3.k but for the Y (vertical) axis for the Kth plot. Note that each of the NYP(K) variables will be plotted on the same scale.

Note: to plot on the versatec plotter at Calspan, the Exec Card should contain the parameters ,plotter=varsatec,long=M

where M=V indicates that the x axis will be in the long (11 inch) direction. For this case, the recommended values for XS(K) and YS(K) are 10.5 and 8.0.

and M=U indicates that the y axis will be in the long direction, and the recommended values for XS(K) and YS(K) are reversed.

In addition, the following card is required at the end of the job:

```
// Exec VPLOT,PCOPY=N
```

where N is the number of copies to be produced.

Card I.5.k	FORMAT (I4, 4X, 15A4)
NXLAB(K)	The number of characters in the label of the x axis for the Kth plot (Max=60, may be zero).
XLAB(K)	The alphanumeric information to be used as the label of the x axis for the Kth plot. Data should be left adjusted as input since program will center the NXLAB(K) characters beneath the x axis.
Card I.6.k	FORMAT (I4, 4X, 15A4)
NYLAB(K), YLAB(K)	Same definition as for Card I.5.k but for the label of the y axis for the Kth plot.
Card I.7.k	FORMAT (I4, 4X, 15A4)
NPLB1(K)	The number of characters in the upper of two lines of plot identification for the Kth plot (Max = 60, may be zero).
PLB(K)	The alphanumeric information to be used in the upper line of the plot identification for the Kth plot. Data should be left adjusted as input since the program will center the NPLB1(K) characters beneath the x axis label.
Card I.8.k	FORMAT (I4, 4X, 15A4)
NPLB2(K), PLB2(K)	Same definition as for Card I.7.k but for the lower line of the plot identification.

Note: the 15A4 term in the format for Cards I.5-I.8 is to be used on computers where a single precision word is equivalent to four alphanumeric characters. This term in the format for Subroutine POSTPR should be to 10A6 or 6A10 for those computers whose single precision word size is equivalent to 6 or 10 characters. This is necessary to insure that a contiguous string of characters is stored in the computer memory as required by Subroutine SYMBOL.

APPENDIX D

PROGRAM MODIFICATIONS AND NEW SUBROUTINE DESCRIPTIONS

APPENDIX D PROGRAM MODIFICATIONS FOR ATB-IIIA MODEL

D.1 SUMMARY OF PROGRAM CHANGES

AERODYNAMIC FORCES

ATB Program Modifications

Subroutine AIRFLW(N)

New subroutine.

Subroutine ARODTA (VREL,CXYZ,CLMN,TBSR)

New subroutine.

Subroutine CONTCT

Subroutine CONTCT has been modified to call Subroutine AIRFLW rather than Subroutine WINDY if MWSEG(1,J) is negative on input Card F.7.a. Note that this requires NWINDF to be nonzero on input Card D.1 which, in turn, requires that NWINDF sets of input Cards E.6 be supplied even though they are not used by the program.

Subroutine FINPUT

Subroutine FINPUT has been modified to accomodate the possibility that MWSEG(1,J) be negative, and not read the corresponding input Card F.7.b for segment No. J if it is negative.

Required ATB Program Input

1. Cards B.2.n:

BD(I,N) for I=1,3: These input data parameters normally contain the x, y and z semiaxes of the contact ellipsoid for segment No. N, but since it is assumed that the contact ellipsoids are not used for segments that are to be subjected to the airstream aerodynamic forces, these input data parameters are used for the following.

BD(I,N) for I=1,2: Two numerical quantities that are multiplied to produce the frontal area (sq. in.) of segment No. N that is presented to the airstream.

BD(3,N): The hydraulic diameter (in) for segment No. N.

BD(I,N) for I=4,6: These input data parameters normally contain the x, y and z coordinates of the center for the contact ellipsoid for segment No. N, but here contain the coordinates (in) of the Standard Reference Point (SRP) with respect to the center of gravity of segment No. N at which the aerodynamic force coefficients are measured.

2. Card D.1:

NWINDF must be nonzero.

3. Cards E.6:

NWINDF sets of input Cards E.6 be supplied even though they are not used by the program.

4. Card F.7.a:

MWSEG(1,J) should be set to -1 for segment No. J. No Card F.7.b should be supplied for this segment.

Optional Output:

NPRT(29) ≠ 0: Produces a tabular time history on the primary output unit of time, mach No., alpha, beta, forces and torques acting on segment No. N. These time points are printed at a frequency of DT (Card A.4) seconds and is interspersed with other output that is printed on the primary output unit.

SUSTAINER ROCKET

Program Modifications

None.

Required ATB Program Input

1. Card D.9.j

2. Cards E.1 to E.4

Defines a function of force (lbs) vs. time (sec) for the sustainer rocket thrust.

Optional Output:

None.

STAPAC ROCKET

Program Modifications

Subroutine WINDY

Subroutine WINDY has been modified to test if the force function number is negative to activate the program for the STAPAC rocket. The pitch rate is computed and used as the argument to a second function that gives the angular deviation to be applied to the nominal firing angle of the STAPAC rocket. The force evaluated from the first function (as a function of time) is then applied at this new firing angle.

Subroutine SINPUT

Subroutine SINPUT has been modified to accept a second function on input Cards D.9.a - D.9.j (the 2I6 term at the beginning of the FORMAT for Cards D.9 has been changed to 3I4). Also, vectors QFU, QFV and QFX are stored in COMMON/WINDFR/ as needed for the STAPAC rocket.

Required ATB Program Input

1. Card D.9.j with new FORMAT (3I4, 6F10.0)

The second item on this card, the identification number of the function that defines force as a function of time, is supplied as a negative integer to activate the STAPAC rocket. The third item (new) is the number of a function that defines angular deviation (radians) from the nominal firing angle as a function of pitch rate (radians/sec).

2. Cards E.1 to E.4

Defines a function of force (lbs) vs. time (sec) for the STAPAC rocket thrust.

3. Cards E.1 to E.4

Defines a function of angular deviation (radians) from the nominal firing angle as a function of pitch rate (radians/sec).

Optional Output:

NPRT(30) ≠ 0: Prints on the primary output unit for diagnostic purposes one line of data at each time point containing time, pitch rate, angular deviation, direction cosines of the firing angle, and components of the resulting force and torque vectors.

DROGUE CHUTE

The drogue chute was modelled taking advantage of several features that already exist in the ATB program. Only one program modification was required. The drogue chute with its suspension lines and riser to the bridle apex point is considered as one rigid segment. The original bridle apex point is assumed to lie in the chute compartment at time zero (initiation of ejection) and the drogue gun forces are modelled by two short duration directed force applications on both the man-seat and chute segments. The chute moves away from the man-seat by the application of this "impulsive" force and by newly added wind force computations on the chute that are controlled by a user supplied CA function. The forces imparted by the chute onto the man-seat segment via the bridle lines are modelled by two tension-only spring dampers between the bridle apex on the chute segment and their attachment points on the back of the man-seat segment.

ATB Program Modifications

Subroutine WINDY

Additions have been made to Subroutine WINDY to compute the wind forces on a chute segment and is controlled by supplying the ellipsoid number (MWSEG(2,J) on input Card F.7.b) as a negative integer. The wind force acting on the chute segment is computed by

FORCE = 0.5 * RHO * V**2 * AREA * CA

where

RHO = The air density stored in COMMOM/ARODAT/ by Subroutine Airflw.

V = The velocity of the chute segment relative to the wind. The wind velocity is stored in COMMON/ARODAT/ by Subroutine AIRFLW.

AREA = PI * A * B where A and B are the y and z semiaxes of the ellipsoid of the chute segment supplied on input Card B.2.j.

CA = The value of a user supplied function from input Cards E to specify the "effective" drag coefficient of the drogue chute as a function of time.

The resulting forces and torques, applied at the end of the negative x axis of the chute ellipsoid, are added to the U1 and U2 arrays.

Required ATB Program Input

1. Cards B.2

The chute c.g. was assumed to be the center of the chute ellipsoid, i.e., the center of the ellipse of the chute opening, with the positive x axis pointed toward the bridle apex.

2. Cards B.3 - B.5

A null joint (all blank cards) is used to "connect" the chute segment with the man-seat segment. This will enable the ATB program to treat the chute segment as a separate body whose motion is computed by the program integrator.

3. Card D.1

The value of NSD should include two spring dampers for the bridle lines from the bridle apex. The value of NFORCE should include two reaction forces of the drogue gun on both the chute and man-seat segments.

4. Cards D.2

An ejection plane (as required by the old Subroutine WINDY) is supplied here but is not currently used by this option (the CA function is expressed as a function of time).

5. Cards D.8

Two tension-only spring damper functions are supplied here to compute the forces imparted by the taut bridle lines connecting the bridle apex on the chute segment and two attachment points on the man-seat segment.

6. Cards D.9

Two impulsive type forces are defined here for the drogue gun forces that are imparted to the chute and man-seat segments.

7. Cards E

Two functions are supplied here to specify the force vs. time impulsive type (i.e., short duration, at least one integration interval) functions for the reaction forces of the drogue gun on both the chute and man-seat segments.

A chute CA function is specified here to specify the "effective" drag coefficient of the drogue chute as a function of time.

8. Cards F.7

MWSEG(1,J) should be set to +1 for the chute segment on Card F.7.a. A Card F.7.b should then be supplied for the chute segment. MWSEG(2,J), the ellipsoid No., should be specified as a negative integer to activate this option. MWSEG(3,J) and (4,J) are not used by the program and MWSEG(5,J) is used here to specify the chute CA function number.

9. Cards G.2 and G.3

Since the chute segment is attached to a null joint, it is another reference segment whose linear position and velocity must be specified on Cards G.2. This must give the values for the c.g. considering that the bridle apex should coincide with the chute compartment on the back of the man-seat segment. The linear velocity should be such that the bridle apex does not separate from the seat while it rides up the rail.

Optional Output:

The results of the tension-only spring dampers are printed on the tabular time histories. Those tabular time histories controlled by input Cards H.1 - H.6 are available to describe the motion of the chute segment.

D.2 NEW SUBROUTINE DESCRIPTIONS

Subroutine AIRFLW(N)

a. Purpose:

Called by Subroutine CONTCT to compute the aerodynamic forces produced by the airsteam and computes the resulting forces and torques acting on segment No. N which are added to the U1 and U2 arrays.

b. Subroutines required:

ELTIME, MAT31, CROSS, ARODTA, DOT31.

c. Labelled common blocks used:

CONTRL, CNSNTS, COMAIN, SGMNTS, CNTSRF, ARODAT, TEMPVS.

d. Input or argument parameters:

1. Arguments:

N - Segment identification number

2. Input parameters currently embedded into subroutine:

RHO - Air density (units are slugs / cu. ft. but converted to inches)
RHO = 0.002375/20376.0

SSOUND - The speed of sound (in/sec).
SSOUND = 12.0*1116.75

WIND(3) - The x, y and z components of the wind vector in inertial reference (in/sec).
WIND(1) = -.908*SSOUND
WIND(2) = 0.0
WIND(3) = 0.0

TDELAY(1) - The time (sec) with respect to initiation of catapult ejection that aerodynamic forces (rocket-on data) are to commence.
TDELAY(1) = 0.213

TDELAY(3) - The time (sec) with respect to initiation of catapult ejection that aerodynamic forces (rocket-off data) are to commence.
TDELAY(3) = TDELAY(1) + 0.394

3. Input parameters currently supplied on input Cards B.2.a:

BD(I,N) for I=1,3: These input data parameters normally contain the x, y and z semiaxes of the contact ellipsoid for segment No. N, but since it is assumed that the contact ellipsoids are not used for segments that are to be subjected to the airstream aerodynamic forces, these input data parameters are used for the following.

BD(I,N) for I=1,2: Two numerical quantities that are multiplied to produce the frontal area (sq. in.) of segment No. N that is presented to the airstream.

BD(3,N): The hydraulic diameter (in) for segment No. N.

BD(I,N) for I=4,6: These input data parameters normally contain the x, y and z coordinates of the center for the contact ellipsoid for segment No. N, but here contain the coordinates (in) of the Seat Reference Point (SRP) with respect to the center of gravity of segment No. N at which the aerodynamic force coefficients are measured.

e. Optional output:

NPRT(29) ≠ 0: Produces a tabular time history on the primary output unit of time, mach No., alpha, beta, forces and torques acting on segment No. N. These time points are printed at a frequency of DT (Card A.4) seconds and is interspersed with other output that is printed on the primary output unit. No time points are printed where time is less than TDELAY(1).

Subroutine ARODTA (VREL,CXYZ,CLMN,TBSR)

a. Purpose:

Called by Subroutine AIRFLW to compute the aeromechanical coefficients, Cx, Cy and Cz for forces and Cl, Cm and Cn for torques, as a function of mach No., angle of attack (Alpha) and sideslip angle (Beta) acting on a man-seat segment subject to the airstream as described in Report No. AFFDL-TR-74-57, "Aeromechanical Properties of Ejection Seat Escape Systems" by B. J. White (April 1974).

b. Subroutines required:

None.

c. Labelled common blocks used:

CNSNTS, ARODAT.

d. Input or argument parameters:

1. Arguments:

VREL(3): The x, y and z components of the velocity of the SRP in the seat-body axes system with respect to the airstream.

CXYZ(3): The force coefficients, Cx, Cy and Cz, that are returned to the calling program.

CLMN(3): The moment coefficients, Cl, Cm and Cn, that are returned to the calling program.

TBSR: Remaining burning time of sustainer rocket. If nwgative and rocket-on data is being used, rocket-off data is read from input unit No. 10.

2. Input Unit No. 10.

On the CDC Cyber computer at WPAFB, this is a file maintained by AFFDL that contains the force and moment coefficient tables from report No. AFFDL-TR-74-57 in a packed format. The first record contains "rocket-on" data and is read into the ICF(18,6,24) array the first time this routine is entered. When the argument TBSR first becomes negative, the second record of this file containing the "rocket-off" data is read into the ICF array. When this routine is used on the CDC Cyber computer at WPAFB, the following control statement is required in the job runstream input:

ATTACH,TAPE10,SMAERO,ID=FDLTR7457,SN=AFFDL,MR=1.

e. Optional output:

None.

APPENDIX E

LISTING OF FORTRAN IV SOURCE DECKS OF ATB-IIIA SUBPROGRAMS

DEVELOPED FOR WPAFB UNDER CONTRACT F33615-80-C-0511

```
      SUBROUTINE AIRFLW(N)                                              GB12MAY82   6
      COMMON/CONTRL/ TIME,NSEG,NJNT,NPL,NBLT,NBAG,NVEH,NGRND,           CONTRL      2
     *               NS,NQ,NSD,NFLX,NHRNSS,NWINDF,NJNTF,NPRT(36)        CONTRL      3
      COMMON/CNSNTS/ PI,RADIAN,G,THIRD,EPS(24),                         CNSNTS      2
     *               UNITL,UNITM,UNITT,GRAVTY(3)                        CNSNTS      3
      COMMON/COMAIN/ VAR(240),DER(240),DT,H0,HMAX,HMIN,RSTIME,          COMAIN      2
     *               ISTEP,NSTEPS,NDINT,NEQ,IRSIN,IRSOUT                COMAIN      3
      COMMON/SGMNTS/ D(3,3,30),WMEG(3,30),WMEGD(3,30),U1(3,30),U2(3,30), SGMNTS     2
     *               SEGLP(3,30),SEGLV(3,30),SEGLA(3,30),NSYM(30)       SGMNTS      3
      COMMON/CNTSRF/ PL(17,30),BELT(20,8),TPTS(6,8),BD(24,40)           CNTSRF      2
      COMMON/RSAVE/  XSG(3,20,3),DPMI(3,3,30),LPMI(30),                 GB08JUN82   1
     *               NSG(7),MSG(20,7),MCG,MCGIN(24,5)                   GB08JUN82   2
      COMMON/ARODAT/ DC(3,3,30),OFFSET(3,30),AREAS(30),REFL(30),        GB12MAY82   2
     *               WIND(3),RHO,TDELAY(10),SSOUND,ICF(18,6,24)         GB12MAY82   3
      COMMON/TEMPVS/ T1(3),T2(3),VREL(3),CXYZ(3),CLMN(3),FRC(3),TRQ(3), GB12MAY82  14
     *               T3(3),T4(3),T5(3),T6(3),T7(3),T8(3),T9(3)          GB12MAY82  15
C     TEMP INPUT INTO COMMON/ARODAT/ FOR THIS ROUTINE.                  GB12MAY82  16
      DATA NFIRST/0/, UOLD/-999.0/                                      GB12MAY82  17
      IF  (NFIRST.NE.0)  GO TO 10                                       GB12MAY82  18
      DO  5  K=1,NSEG                                                   GB12MAY82  19
      DO  4  J=1,3                                                      GB12MAY82  20
      DO  3  I=1,3                                                      GB12MAY82  21
    3 DC(I,J,K) = 0.0                                                   GB12MAY82  22
      DC(J,J,K) = 1.0                                                   GB12MAY82  23
    4 OFFSET(J,K) = BD(J+3,K)                                           GB12MAY82  24
      AREAS(K) = BD(1,K)*BD(2,K)                                        GB12MAY82  25
    5 REFL(K) = BD(3,K)                                                 GB12MAY82  26
      RHO     = 0.002375/20736.0                                        GB12MAY82  27
      SSOUND  = 12.0*1116.75                                            GB12MAY82  28
      WIND(1) =-0.908*SSOUND                                            GB12MAY82  29
      WIND(2) = 0.0                                                     GB12MAY82  30
      WIND(3) = 0.0                                                     GB12MAY82  31
      TDELAY(1) = 0.213                                                 GB12MAY82  32
      TDELAY(2) = TDELAY(1)                                             GB12MAY82  33
      TDELAY(3) = TDELAY(2) + 0.394                                     GB12MAY82  34
   10 NFIRST = 1                                                        GB12MAY82  35
      CALL ELTIME(1,40)                                                 GB12MAY82  36
      IF  (TIME.LE.TDELAY(1))  GO TO 30                                 GB12MAY82  37
C                                                                       GB12MAY82  38
C     COMPUTE VELOCITY OF SEGMENT N RELATIVE TO WIND                    GB12MAY82  39
C                                                                       GB12MAY82  40
      DO  11  I=1,3                                                     GB12MAY82  41
   11 T1(I) = SEGLV(I,N) - WIND(I)                                      GB12MAY82  42
      IF  (LPMI(N).EQ.0)  GO TO 21                                      GB12MAY82  43
      CALL DOT33 (DPMI(1,1,N),D(1,1,N),T4)                              GB12MAY82  44
      CALL MAT31 (T4,T1,T2)                                             GB12MAY82  45
      GO TO 22                                                          GB12MAY82  46
   21 CALL MAT31 (D(1,1,N),T1,T2)                                       GB12MAY82  47
   22 CALL CROSS (WMEG(1,N),OFFSET(1,N),T3)                             GB12MAY82  48
      DO  12  I=1,3                                                     GB12MAY82  49
   12 T4(I) = T2(I) + T3(I)                                             GB12MAY82  50
      CALL MAT31 (DC(1,1,N),T4,VREL)                                    GB12MAY82  51
C                                                                       GB12MAY82  52
```

```
C     COMPUTE AEROMECHANICAL COEFFICIENTS FROM AFFDL-TR-74-57 DATA
C
      TBSR = TDELAY(3) - TIME
      CALL ARODTA (VREL,CXYZ,CLMN,TBSR)
C
C     COMPUTE FORCE AND TORQUE ON SEGMENT J, ADD TO U1 & U2 ARRAYS
C
      V2 = VREL(1)**2 + VREL(2)**2 + VREL(3)**2
      CONXYZ = 0.5*RHO*V2*AREAS(N)
      CONLMN = CONXYZ*REFL(N)
      DO  13  I=1,3
      T5(I) = CONXYZ*CXYZ(I)
   13 T6(I) = CONLMN*CLMN(I)
      CALL DOT31 (DC(1,1,N),T5,FRC)
      CALL DOT31 (DC(1,1,N),T6,TRQ)
      CALL CROSS (OFFSET(1,N),FRC,T7)
      CALL DOT31 (D(1,1,N),FRC,T8)
      DO  14  I=1,3
      TRQ(I)   = TRQ(I)   + T7(I)
      U1(I,N) = U1(I,N) + T8(I)
   14 U2(I,N) = U2(I,N) + TRQ(I)
   30 IF  (NPRT(29).EQ.0)  GO TO 99
      IF  (TIME.EQ.0.0)  WRITE (6,31)
   31 FORMAT(1H1,4X,4HTIME,8X,4HMACH,5X,5HALPHA,5X,4HBETA,
     *        11X,2HCX,8X,2HCY,8X,2HCZ,12X,2HCL,8X,2HCM,8X,2HCN//)
      IF  (TIME.LT.TDELAY(1))  GO TO 99
      TEST  = AMOD(TIME,DT)
      TEST  = AMIN1(TEST,ABS(DT-TEST))
      IF  (UOLD.GE.0.0 .AND. TEST.GT.EPS(6))  GO TO 99
      USEC  = 1000.0*TIME
      IF  (ABS(USEC-UOLD).LT.EPS(1))  GO TO 99
      UOLD = USEC
      XMACH = SQRT(V2)/SSOUND
      ALPHA = ATAN2(VREL(3),VREL(1))/RADIAN
      BETA  = ATAN2(VREL(2),SQRT(VREL(1)**2+VREL(3)**2))/RADIAN
      CALL MAT31 (DC(1,1,N),TRQ,T9)
      WRITE (6,32) USEC,XMACH,ALPHA,BETA,T5,T9
   32 FORMAT (F9.2,4X,F9.4,2F9.2,4X,3F10.2,4X,3F10.2)
   99 CALL ELTIME (2,40)
      RETURN
      END
```

```
      SUBROUTINE ARODTA (VREL,CXYZ,CLMN,TBSR)                           GB12MAY82  95
C     GIVEN: -PI   .LT. ALPHA .LE. +PI                                  GB12MAY82  96
C            -PI/2 .LE. BETA  .LE. +PI/2                                GB12MAY82  97
C             0.6 .LE. VEL   .LE. 1.5   (MACH)                          GB12MAY82  98
C     RETURN: CXYZ(3),CLMN(3)                                           GB12MAY82  99
      DIMENSION VREL(3),CXYZ(3),CLMN(3)                                 GB12MAY82 100
      COMMON/CNSNTS/ PI,RADIAN,G,THIRD,EPS(24),                         CNSNTS      2
     *               UNITL,UNITM,UNITT,GRAVTY(3)                        CNSNTS      3
      COMMON/ARODAT/ DC(3,3,30),OFFSET(3,30),AREAS(30),REFL(30),        GB12MAY82   2
     *               WIND(3),RHO,TDELAY(10),SSOUND,ICF(18,6,24)         GB12MAY82   3
      DATA  CMIN/-1.5/ , BN/16383.0/ , RANGE/3.0/                       GB12MAY82 103
      DATA  JDUNIT/0/ , IDUNIT/10/                                      GB12MAY82 104
      IF  (JDUNIT.NE.0)  GO TO 11                                       GB12MAY82 105
C       **  FIRST TIME IN ROUTINE, READ DOBBEK DATA.  NEEDS  **          GB12MAY82 106
C           ATTACH,TAPE10,SMAERO,ID=FDLTR7457,SN=AFFDL,MR=1.            GB12MAY82 107
C           NOTE: 1ST RECORD IS "ROCKET ON"  DATA                       GB12MAY82 108
C                 2ND RECORD IS "ROCKET OFF" DATA                       GB12MAY82 109
      JDUNIT = 1                                                        GB12MAY82 110
      REWIND IDUNIT                                                     GB12MAY82 111
      READ  (IDUNIT)  ICF                                               GB12MAY82 112
      NFIRE = 1                                                         GB12MAY82 113
      DA  = 5.0*RADIAN                                                  GB12MAY82 114
      DB1 = 5.0*RADIAN                                                  GB12MAY82 115
      DB2 = 15.0*RADIAN                                                 GB12MAY82 116
      DV  = 0.3*SSOUND                                                  GB12MAY82 117
      V1  = 0.6*SSOUND                                                  GB12MAY82 118
   11 IF  (NFIRE.EQ.0)  GO TO 12                                        GB12MAY82 119
      IF  (TBSR.GT.0.0)  GO TO 12                                       GB12MAY82 120
      READ  (IDUNIT)  ICF                                               GB12MAY82 121
      NFIRE = 0                                                         GB12MAY82 122
C       **  COMPUTE INDEX AND WEIGHTS FOR ALPHA      **                 GB12MAY82 123
   12 ALPHA = ATAN2(VREL(3),VREL(1))                                    GB12MAY82 124
      XA = 1.0 + ALPHA/DA                                               GB12MAY82 125
      IF  (XA.LT.1.0)  XA = XA + 72.0                                   GB12MAY82 126
      IF  (XA.LT.1.0 .OR. XA.GE.73.0)  STOP                             GB12MAY82 127
      IX1 = XA                                                          GB12MAY82 128
      IX2 = IX1 + 1                                                     GB12MAY82 129
      RX2 = XA - FLOAT(IX1)                                             GB12MAY82 130
C       **  COMPUTE INDEX AND WEIGHTS FOR BETA       **                 GB12MAY82 131
      BETA = ATAN2(VREL(2),SQRT(VREL(1)**2+VREL(3)**2))                 GB12MAY82 132
      XB  = 1.0 + ABS(BETA)/DB1                                         GB12MAY82 133
      IF  (XB.GT.4.0)  XB = 3.0 + ABS(BETA)/DB2                         GB12MAY82 134
      XB  = AMIN1(XB,6.0)                                               GB12MAY82 135
      IY1 = XB                                                          GB12MAY82 136
      IY2 = IY1 + 1                                                     GB12MAY82 137
      RY2 = XB - FLOAT(IY1)                                             GB12MAY82 138
C       **  COMPUTE INDEX AND WEIGHTS FOR MACH NO.  **                  GB12MAY82 139
      VEL = SQRT(VREL(1)**2+VREL(2)**2+VREL(3)**2)                      GB12MAY82 140
      XV  = 1.0 + (VEL-V1)/DV                                           GB12MAY82 141
      XV  = AMAX1(XV,1.0)                                               GB12MAY82 142
      XV  = AMIN1(XV,4.0)                                               GB12MAY82 143
      IZ1 = XV                                                          GB12MAY82 144
      IZ2 = IZ1 + 1                                                     GB12MAY82 145
```

```
      RZ2 = XV - FLOAT(IZ1)                                             GB12MAY82 146
C       **  FETCH AND UNPACK DOBBEK DATA                    **          GB12MAY82 147
C       **  TRIPLE LINEAR INTERPOLATION ON CUBE             **          GB12MAY82 148
      DO  21  K=1,3                                                     GB12MAY82 149
      CXYZ(K)  = 0.0                                                    GB12MAY82 150
   21 CLMN(K)  = 0.0                                                    GB12MAY82 151
      RX  = 1.0 - RX2                                                   GB12MAY82 152
      DO  34  JX=IX1,IX2                                                GB12MAY82 153
      IF  (RX.EQ.0.0)  GO TO 34                                         GB12MAY82 154
      IX  = (JX+3)/4                                                    GB12MAY82 155
      IF  (IX.EQ.19)  IX = 1                                            GB12MAY82 156
      IS  = 15*MOD(JX,4)                                                GB12MAY82 157
      RY  = 1.0 - RY2                                                   GB12MAY82 158
      DO  33  JY=IY1,IY2                                                GB12MAY82 159
      IF  (RY.EQ.0.0)  GO TO 33                                         GB12MAY82 160
      RXY = RX*RY                                                       GB12MAY82 161
      RZ  = 1.0 - RZ2                                                   GB12MAY82 162
      DO  32  JZ=IZ1,IZ2                                                GB12MAY82 163
      IF  (RZ.EQ.0.0)  GO TO 32                                         GB12MAY82 164
      RXYZ = RXY*RZ                                                     GB12MAY82 165
      DO  31  K=1,6                                                     GB12MAY82 166
      KZ  = 4*(K-1) + JZ                                                GB12MAY82 167
      M   = ICF(IX,JY,KZ)                                               GB12MAY82 168
      IF  (IS.NE.0)  M = SHIFT(M,IS)                                    GB12MAY82 169
      M   = AND(M,32767)                                                GB12MAY82 170
      CC  = CMIN + ((FLOAT(M)+0.5)/BN)*RANGE                            GB12MAY82 171
      IF  (K.LE.3)  CXYZ(K   ) = CXYZ(K   ) + RXYZ*CC                   GB12MAY82 172
   31 IF  (K.GT.3)  CLMN(K-3) = CLMN(K-3) + RXYZ*CC                     GB12MAY82 173
   32 RZ  = RZ2                                                         GB12MAY82 174
   33 RY  = RY2                                                         GB12MAY82 175
   34 RX  = RX2                                                         GB12MAY82 176
      IF  (BETA.LE.0.0)  GO TO 99                                       GB12MAY82 177
      CXYZ(2) = -CXYZ(2)                                                GB12MAY82 178
      CLMN(1) = -CLMN(1)                                                GB12MAY82 179
      CLMN(3) = -CLMN(3)                                                GB12MAY82 180
   99 RETURN                                                            GB12MAY82 181
      END                                                               GB12MAY82 182
```

```
CDECK CHAIN                                                            CHAIN        2
      SUBROUTINE CHAIN                                                 CHAIN        3
C                                                    REV 21 06/08/82  GB08JUN82    3
C     COMPUTES THE LINEAR POSITION AND VELOCITY IN INERTIAL REFERENCE  CHAIN        5
C     OF BODY SEGMENTS FROM THOSE OF THE REFERENCE SEGMENTS            CHAIN        6
C     (I.E., SEGMENT NO. 1 AND EACH SEGMENT J FOR WHICH JNT(J)=0).     CHAIN        7
C                                                                      CHAIN        8
      COMMON/CONTRL/ TIME,NSEG,NJNT,NPL,NBLT,NBAG,NVEH,NGRND,          CONTRL       2
     *               NS,NQ,NSD,NFLX,NHRNSS,NWINDF,NJNTF,NPRT(36)       CONTRL       3
      COMMON/SGMNTS/ D(3,3,30),WMEG(3,30),WMEGD(3,30),U1(3,30),U2(3,30), SGMNTS     2
     *               SEGLP(3,30),SEGLV(3,30),SEGLA(3,30),NSYM(30)      SGMNTS       3
      COMMON/DESCRP/ PHI(3,30),W(30),RW(30),SR(3,60),HA(3,60),HB(3,60), DESCRP     2
     *               RPHI(3,30),HT(3,3,60),SPRING(5,90),VISC(7,90),    DESCRP       3
     *               JNT(30),IPIN(30),ISING(30),IGLOB(30),JOINTF(30)   DESCRP       4
      COMMON/CEULER/ IEULER(30),HIR(3,3,30),ANG(3,30),ANGD(3,30),      CEULER       2
     *               FE(3,30),TQE(3,30),CONST(3,30)                    CEULER       3
      COMMON/CNSNTS/ PI,RADIAN,G,THIRD,EPS(24),                        CNSNTS       2
     *               UNITL,UNITM,UNITT,GRAVTY(3)                       CNSNTS       3
      COMMON/TEMPVS/ T1(3),T2(3),T3(3),T4(3),TP(3,3)                   GB08JUN82    6
      CALL ELTIME (1,11)                                               GB08JUN82    7
      IF  (NJNT.EQ.0)  GO TO 71                                        GB08JUN82    8
      DO  70  J=1,NJNT                                                 GB08JUN82    9
      K = IABS(JNT(J))                                                 GB08JUN82   10
      IF  (K.EQ.0)  GO TO 70                                           GB08JUN82   11
      IF  (ISING(J+1).LT.0)  GO TO 70                                  GB08JUN82   12
      IF  (NPRT(36).EQ.0)  GO TO 51                                    GB08JUN82   13
C                                                                      GB08JUN82   14
C     IF NPRT(36) IS NONZERO ON INPUT CARD A.5,                        GB08JUN82   15
C     THEN CORRECT DRIFT OF CONSTRAINED JOINTS.                        GB08JUN82   16
C                                                                      GB08JUN82   17
      M = 0                                                            GB08JUN82   18
      IF  (IPIN(J).EQ.1)    M = 2                                      GB08JUN82   19
      IF  (IABS(IPIN(J)).NE.4)  GO TO 21                               GB08JUN82   20
      IF  (IEULER(J).EQ.4)  M = 1                                      GB08JUN82   21
      IF  (IEULER(J).EQ.5)  M = 2                                      GB08JUN82   22
      IF  (IEULER(J).EQ.6)  M = 3                                      GB08JUN82   23
   21 IF  (M.EQ.0)  GO TO 51                                           GB08JUN82   24
C                                                                      GB08JUN82   25
C     **  ADJUST DC MATRIX FOR CONSTRAINED JOINTS  **                  GB08JUN82   26
C                                                                      GB08JUN82   27
      CALL DOT31 (D(1,1,K),HT(1,M,2*J-1),T1)                           GB08JUN82   28
      CALL MAT31 (D(1,1,J+1),T1,T2)                                    GB08JUN82   29
      CALL CROSS (HT(1,M,2*J),T2,T3)                                   GB08JUN82   30
      CT = T2(1)*HT(1,M,2*J) + T2(2)*HT(2,M,2*J) + T2(3)*HT(3,M,2*J)   GB08JUN82   31
      DO  30  L=1,3                                                    GB08JUN82   32
      CALL CROSS (T3,D(1,L,J+1),T4)                                    GB08JUN82   33
      ST = T3(1)*D(1,L,J+1) + T3(2)*D(2,L,J+1) + T3(3)*D(3,L,J+1)      GB08JUN82   34
      ST = ST/(1.0+CT)                                                 GB08JUN82   35
      DO  30  I=1,3                                                    GB08JUN82   36
   30 D(I,L,J+1) = CT*D(I,L,J+1) - T4(I) + ST*T3(I)                    GB08JUN82   37
C                                                                      GB08JUN82   38
C     **  RENORMALIZATION OF DIRECTION COSINE MATRIX BY **             GB08JUN82   39
C     **  AVERAGING MATRIX AND TRANSPOSE OF ITS INVERSE **             GB08JUN82   40
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C                                                                       GB08JUN82
      DO  33  ITER=1,10                                                 GB08JUN82
      CALL CFACTT (D(1,1,J+1),TP,DET)                                   GB08JUN82
      DO  32  L=1,3                                                     GB08JUN82
      DO  32  I=1,3                                                     GB08JUN82
      D(I,L,J+1) = 0.5*(D(I,L,J+1)+TP(L,I)/DET)                         GB08JUN82
   32 IF  (ABS(D(I,L,J+1)).LT.EPS(15))  D(I,L,J+1) = 0.0                GB08JUN82
      IF  (ABS(DET-1.0).LT.EPS(6))  GO TO 41                            GB08JUN82
   33 CONTINUE                                                          GB08JUN82
      WRITE  (6,34)  J,TIME,DET                                         GB08JUN82
   34 FORMAT (44H0 CHAIN RENORMALIZATION DID NOT CONVERGE FOR,          GB08JUN82
     *        10H JOINT NO.,I3,7H TIME =,F10.6,6H DET =,F10.6)          GB08JUN82
C                                                                       GB08JUN82
C     **  ADJUST WMEG FOR CONSTRAINED JOINTS  **                        GB08JUN82
C                                                                       GB08JUN82
   41 HW = HT(1,M,2*J)*WMEG(1,J+1) - HT(1,M,2*J-1)*WMEG(1,K)            GB08JUN82
     *   + HT(2,M,2*J)*WMEG(2,J+1) - HT(2,M,2*J-1)*WMEG(2,K)            GB08JUN82
     *   + HT(3,M,2*J)*WMEG(3,J+1) - HT(3,M,2*J-1)*WMEG(3,K)            GB08JUN82
      CALL DOT31 (D(1,1,K),WMEG(1,K),T1)                                GB08JUN82
      CALL MAT31 (D(1,1,J+1),T1,WMEG(1,J+1))                            GB08JUN82
      DO  50  I=1,3                                                     GB08JUN82
   50 WMEG(I,J+1) = WMEG(I,J+1) + HW*HT(I,M,2*J)                        GB08JUN82
C                                                                       GB08JUN82
C     COMPUTE SEGMENT POSITIONS BY                                      GB08JUN82
C      P(J+1) = P(K) + D(K)'*R(K,J) - D(J+1)'*R(J+1,J)                  GB08JUN82
C                                                                       GB08JUN82
C     COMPUTE SEGMENT VELOCITIES BY                                     GB08JUN82
C      V(J+1) = V(K) + D(K)'*W(K) X R(K,J) - D(J+1)'*W(J+1) X R(J+1,J)  GB08JUN82
C                                                                       GB08JUN82
   51 CALL CROSS (WMEG(1,K),SR(1,2*J-1),T1)                             GB08JUN82
      CALL DOT31 (D(1,1,K),T1,T3)                                       GB08JUN82
      CALL CROSS (WMEG(1,J+1),SR(1,2*J),T2)                             GB08JUN82
      CALL DOT31 (D(1,1,J+1),T2,T4)                                     GB08JUN82
      CALL DOT31 (D(1,1,K),SR(1,2*J-1),T1)                              GB08JUN82
      CALL DOT31 (D(1,1,J+1),SR(1,2*J),T2)                              GB08JUN82
      DO  60  I=1,3                                                     GB08JUN82
      SEGLP(I,J+1) = SEGLP(I,K) + T1(I) - T2(I)                         GB08JUN82
   60 SEGLV(I,J+1) = SEGLV(I,K) + T3(I) - T4(I)                         GB08JUN82
   70 CONTINUE                                                          CHAIN
C                                                                       CHAIN
C     OPTIONAL OUTPUT                                                   CHAIN
C                                                                       CHAIN
   71 IF  (NPRT(20).NE.0)  WRITE (6,90)  TIME                           CHAIN
     *                        ,((SEGLP(I,J),I=1,3),J=1,NSEG)            CHAIN
     *                        ,((SEGLV(I,J),I=1,3),J=1,NSEG)            CHAIN
   90 FORMAT("0 LINEAR POSITIONS AND VELOCITIES OF BODY SEGMENTS FROM CH CHAIN
     *AIN FOR TIME =",F12.6/(9F13.5))                                   CHAIN
      CALL ELTIME(2,11)                                                 CHAIN
      RETURN                                                            CHAIN
      END                                                               CHAIN
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CDECK HBPLAY                                                            HBPLAY
      SUBROUTINE HBPLAY                                                 HBPLAY
C                                                 REV 21 12/17/82 GB17DEC82
      COMMON/CONTRL/ TIME,NSEG,NJNT,NPL,NBLT,NBAG,NVEH,NGRND,           CONTRL
     *               NS,NQ,NSD,NFLX,NHRNSS,NWINDF,NJNTF,NPRT(36)        CONTRL
      COMMON/CNTSRF/ PL(17,30),BELT(20,8),TPTS(6,8),BD(24,40)           CNTSRF
      COMMON/SGMNTS/ D(3,3,30),WMEG(3,30),WMEGD(3,30),U1(3,30),U2(3,30), SGMNTS
     *               SEGLP(3,30),SEGLV(3,30),SEGLA(3,30),NSYM(30)       SGMNTS
      COMMON/HRNESS/ BAR(15,100),BB(100),BBDOT(100),PLOSS(2,100),       HRNESS
     *               XLONG(20),HTIME(2),IBAR(5,100),NL(2,100),          HRNESS
     *               NPTSPB(20),NPTPLY(20),NTHRNS(20),NBLTPH(5)         HRNESS
C     THIS COMMON/TEMPVS/ IS SHARED BY HPTURB, HBPLAY, HBELT AND HSETC.  TMPVSH
      COMMON/TEMPVS/ B(3,3,3),S(3,3),T(3),R(3),V(3),T1(3),T2(3),        TMPVSH
     *               E(3,3,50),EDOT(3,50),FCE(3,50),FR(3,50),ZR(3,50),  TMPVSH
     *               TR(3,50),U(3,50),PTLOSS(2,50),BL(50),FB(50),FP(50), TMPVSH
     *               OLDBB(100),RHS(3,54),C(3,3,200),IJK(54,54)         TMPVSH
      IF  (NHRNSS.LE.0)  GO TO 99                                       HBPLAY
C                                                                       HBPLAY
C     SAVE PREVIOUS NL,BB AND PLOSS ARRAYS.                             HBPLAY
C     USE IJK,OLDBB AND PTLOSS AS TEMP STORAGE.                         HBPLAY
C                                                                       HBPLAY
      DO  10  I=1,100                                                   HBPLAY
      IJK(I,1) = NL(1,I)                                                HBPLAY
      PTLOSS(I,1) = PLOSS(1,I)                                          HBPLAY
   10 OLDBB(I) = BB(I)                                                  HBPLAY
      JNL = 1                                                           HBPLAY
      J1 = 1                                                            HBPLAY
      K1 = 1                                                            HBPLAY
      LL = 0                                                            HBPLAY
      DO  90  NH=1,NHRNSS                                               HBPLAY
      IF  (NBLTPH(NH).LE.0)  GO TO 90                                   HBPLAY
      J2 = J1 + NBLTPH(NH) - 1                                          HBPLAY
      DO  80  NB=J1,J2                                                  HBPLAY
      L1 = LL                                                           HBPLAY
      IF  (NPTSPB(NB).LE.0)  GO TO 80                                   HBPLAY
      K2 = K1 + NPTSPB(NB) - 1                                          HBPLAY
      KB = 0                                                            HBPLAY
      DO  30  K=K1,K2                                                   HBPLAY
      KB = KB + 1                                                       HBPLAY
C                                                                       HBPLAY
C     HERE K IS INDEX OF ALL POINTS                                     HBPLAY
C         KB IS INDEX OF POINTS ON A SINGLE BELT                        HBPLAY
C         LL IS INDEX OF ALL POINTS IN PLAY                             HBPLAY
C         JB IS INDEX OF PREVIOUS POINT ON BELT IN PLAY                 HBPLAY
C                                                                       HBPLAY
      KS = IABS(IBAR(1,K))                                              HBPLAY
      IF  (KS.GT.100)  KS = MOD(KS,100)                                 HBPLAY
      CALL DOT31 (D(1,1,KS),BAR(4,K),T1)                                HBPLAY
      CALL DOT31 (D(1,1,KS),BAR(7,K),T2)                                HBPLAY
      DO  11  J=1,3                                                     HBPLAY
   11 U(J,KB) = SEGLP(J,KS) + T1(J) + T2(J)                             HBPLAY
      IF  (K.EQ.K1)  GO TO 30                                           HBPLAY
      LL = LL + 1                                                       HBPLAY
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   12 JJ = NL(1,LL)                                                 HBPLAY
      JB = JJ - K1 + 1                                              HBPLAY
      DSS = 0.0                                                     HBPLAY
      DO  13  J=1,3                                                 HBPLAY
      ZR(J,KB) = U(J,KB) - U(J,JB)                                  HBPLAY
   13 DSS = DSS + ZR(J,KB)**2                                       HBPLAY
      BL(LL) =  SQRT(DSS)                                           HBPLAY
      IF  (JJ.EQ.K1 .OR. IABS(IBAR(1,JJ)).GT.100)  GO TO 30         HBPLAY
      JS = IBAR(1,JJ)                                               HBPLAY
      JE = IBAR(2,JJ)                                               HBPLAY
      IF  (JE.LE.0)  GO TO 30                                       HBPLAY
      CALL MAT31 (BD(7,JE),BAR(4,JJ),T2)                            HBPLAY
      CALL DOT31 (D(1,1,JS),T2,R)                                   HBPLAY
      DPR = 0.0                                                     HBPLAY
      DO  17  J=1,3                                                 HBPLAY
   17 DPR = DPR + R(J)*(ZR(J,KB)/BL(LL) - ZR(J,JB)/BL(LL-1))        HBPLAY
      IF  (DPR.LT.0.0)  GO TO 30                                    HBPLAY
      LL = LL - 1                                                   HBPLAY
      GO TO 12                                                      HBPLAY
   30 NL(1,LL+1) = K                                                HBPLAY
      L2 = L1 + 1                                                   HBPLAY
      LL = LL + 1                                                   HBPLAY
      L3 = LL-1                                                     HBPLAY
      DO  31  J=L2,LL                                               HBPLAY
   31 NL(2,J) = NTHRNS(NB)                                          HBPLAY
      IF  (XLONG(NB).EQ.0.0)  GO TO 35                              HBPLAY
C                                                                   HBPLAY
C     FIRST TIME IN ROUTINE, SET INITIAL BB ARRAY.                  HBPLAY
C     INPUT XLONG MUST BE NON-ZERO TO TRIGGER THIS TEST.            HBPLAY
C                                                                   HBPLAY
      XLG = 0.0                                                     HBPLAY
      DO  32  J=L2,L3                                               HBPLAY
   32 XLG = XLG + BL(J)                                             HBPLAY
      XLG = 1.0 + XLONG(NB)/XLG                                     HBPLAY
      DO  33  J=L2,L3                                               HBPLAY
   33 BB(J) = XLG*BL(J)                                             HBPLAY
      XLONG(NB) = 0.0                                               HBPLAY
      GO TO 52                                                      HBPLAY
C                                                                   HBPLAY
C     DETERMINE IF NEW NL ARRAY IS DIFFERENT FROM PREVIOUS NL ARRAY. HBPLAY
C     IF SO, RECOMPUTE BB ELEMENTS FOR POINTS THAT ARE DIFFERENT.   HBPLAY
C                                                                   HBPLAY
   35 IF  (NL(1,L2).EQ.IJK(JNL,1))  GO TO 61                        HBPLAY
      WRITE (6,62)                                                  HBPLAY
   62 FORMAT ("0 LOGIC ERROR IN SUB HBPLAY. PROGRAM TERMINATED.")   HBPLAY
      STOP 42                                                       HBPLAY
   61 LTEST = 0                                                     HBPLAY
      M = L2                                                        HBPLAY
      N = JNL                                                       HBPLAY
   36 IF  (NL(1,M+1)-IJK(N+1,1))  39,37,41                          HBPLAY
   37 BB(M) = OLDBB(N)                                              HBPLAY
      PLOSS(1,M) = PTLOSS(N,1)                                      HBPLAY
   38 M = M+1                                                       HBPLAY
      N = N+1                                                       HBPLAY
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      IF  (M-LL)  36,51,51                                              HBPLAY     110
C                                                                       HBPLAY     111
C     POINT M+1 IS NEW.                                                 HBPLAY     112
C                                                                       HBPLAY     113
   39 M0 = M                                                            HBPLAY     114
      N0 = N                                                            HBPLAY     115
      LTEST = 1                                                         HBPLAY     116
   40 M = M+1                                                           HBPLAY     117
C                                                                       GB17DEC82    2
C     MODIFY NEW POINT TO LIE IN BELT PLANE                             GB17DEC82    3
C                                                                       GB17DEC82    4
        IP1 = N - 1                                                     GB17DEC82    5
        IF  (N.GT.JNL)  GO TO 63                                        GB17DEC82    6
        IP1 = N                                                         GB17DEC82    7
C       (IS THIRD POINT AVAILABLE FROM OLD POINTS IN PLAY?)             GB17DEC82    8
        IF  (IJK(N+1,1).EQ.NL(1,LL))  GO TO 43                          GB17DEC82    9
   63   DO  64  I=1,3                                                   GB17DEC82   10
        IP = IP1 + I - 1                                                GB17DEC82   11
C       (USE OLD POINTS IP = N-1,N,N+1 IF N > JNL                       GB17DEC82   12
C                    OR IP = N,N+1,N+2 IF N = JNL AND N+2 EXISTS)       GB17DEC82   13
        NI = IJK(IP,1)                                                  GB17DEC82   14
        NS = IABS(IBAR(1,NI))                                           GB17DEC82   15
        IF  (NS.GT.100)  NS = MOD(NS,100)                               GB17DEC82   16
        CALL DOT31 (D(1,1,NS),BAR(4,NI),T1)                             GB17DEC82   17
        CALL DOT31 (D(1,1,NS),BAR(7,NI),T2)                             GB17DEC82   18
        DO  64  J=1,3                                                   GB17DEC82   19
   64   S(J,I) = SEGLP(J,NS) + T1(J) + T2(J)                            GB17DEC82   20
        DO  65  J=1,3                                                   GB17DEC82   21
        S(J,3) = S(J,3) - S(J,2)                                        GB17DEC82   22
   65   S(J,2) = S(J,2) - S(J,1)                                        GB17DEC82   23
C       (S(*,1) IS POINT P1 IN INERTIAL REFERENCE)                      GB17DEC82   24
C       (S(*,2) IS VECTOR (P2-P1) IN INERTIAL REFERENCE)                GB17DEC82   25
C       (S(*,3) IS VECTOR (P3-P2) IN INERTIAL REFERENCE)                GB17DEC82   26
        CALL CROSS (S(1,3),S(1,2),T2)                                   GB17DEC82   27
        ABST = SQRT(T2(1)**2 + T2(2)**2 + T2(3)**2)                     GB17DEC82   28
        DO  66  J=1,3                                                   GB17DEC82   29
   66   T2(J) = T2(J)/ABST                                              GB17DEC82   30
C       (T2 IS T, THE NORMALIZED PLANE VECTOR IN INERTIAL REFERENCE)    GB17DEC82   31
        MI = NL(1,M)                                                    GB17DEC82   32
        MS = IABS(IBAR(1,MI))                                           GB17DEC82   33
        IF  (MS.GT.100)  MS = MOD(MS,100)                               GB17DEC82   34
        ME = IBAR(2,MI)                                                 GB17DEC82   35
        CALL MAT31 (D(1,1,MS),T2,T1)                                    GB17DEC82   36
C       (T1 IS T IN ELLIPSOID REFERENCE OF NEW POINT M)                 GB17DEC82   37
        D1 = T2(1)*S(1,1) + T2(2)*S(2,1) + T2(3)*S(3,1)                 GB17DEC82   38
        D2 = T1(1)*BAR(7,MI) + T1(2)*BAR(8,MI) + T1(3)*BAR(9,MI)        GB17DEC82   39
        D3 = T2(1)*SEGLP(1,MS) + T2(2)*SEGLP(2,MS) + T2(3)*SEGLP(3,MS)  GB17DEC82   40
        DD = D1 - D2 - D3                                               GB17DEC82   41
C       (DD IS D, THE DISTANCE OF ELLIPSOID CENTER TO PLANE)            GB17DEC82   42
        CALL MAT31 (BD(16,ME),T1,R)                                     GB17DEC82   43
        BX = DD/(T1(1)*R(1) + T1(2)*R(2) + T1(3)*R(3))                  GB17DEC82   44
        D4 = T1(1)*BAR(4,MI) + T1(2)*BAR(5,MI) + T1(3)*BAR(6,MI)        GB17DEC82   45
        DO  67  J=1,3                                                   GB17DEC82   46
        R(J) = BX*R(J)                                                  GB17DEC82   47
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C       (R IS S, THE CENTER OF THE ELLIPSE)                                  GB17DEC82  48
  67    V(J) = BAR(J+3,MI) + (DD-D4)*T1(J)                                   GB17DEC82  49
C       (BAR(J+3,MI) IS P, THE NEW POINT TO BE ADDED)                        GB17DEC82  50
C       (V IS Q, THE PROJECTION OF POINT P ONTO THE PLANE)                   GB17DEC82  51
        AX = SQRT( (BX*DD-1.0) / (BX*DD-XDY(V,BD(7,ME),V)) )                 GB17DEC82  52
        DO  68  J=1,3                                                        GB17DEC82  53
  68    BAR(J+3,MI) = R(J) + AX*(V(J)-R(J))                                  GB17DEC82  54
C       (BAR(J+3,MI) IS R = S + A(Q - S), Q EXTENDED TO ELLIPSOID)           GB17DEC82  55
      GO TO 43                                                               HBPLAY    118
C                                                                            HBPLAY    119
C      POINT N+1 IS DROPPED.                                                 HBPLAY    120
C                                                                            HBPLAY    121
  41  M0 = M                                                                 HBPLAY    122
      N0 = N                                                                 HBPLAY    123
      LTEST = 1                                                              HBPLAY    124
  42  N = N+1                                                                HBPLAY    125
  43  IF  (NL(1,M+1)-IJK(N+1,1))  40,44,42                                   HBPLAY    126
C                                                                            HBPLAY    127
C     POINTS N0 TO N+1 ARE BEING REPLACED WITH POINTS M0 TO M+1.             HBPLAY    128
C                                                                            HBPLAY    129
  44  SUMBL = 0.0                                                            HBPLAY    130
      DO  45  J=M0,M                                                         HBPLAY    131
  45  SUMBL = SUMBL + BL(J)                                                  HBPLAY    132
      SUMPL = 0.0                                                            HBPLAY    133
      SUMBB = 0.0                                                            HBPLAY    134
      DO  46  J=N0,N                                                         HBPLAY    135
      SUMPL = SUMPL + PTLOSS(J,1)                                            HBPLAY    136
  46  SUMBB = SUMBB + OLDBB(J)                                               HBPLAY    137
      RATPL = SUMPL/SUMBL                                                    HBPLAY    138
      RATIO = SUMBB/SUMBL                                                    HBPLAY    139
      DO  47  J=M0,M                                                         HBPLAY    140
      PLOSS(1,J) = RATPL*BL(J)                                               HBPLAY    141
  47  BB(J) = RATIO*BL(J)                                                    HBPLAY    142
      GO TO 38                                                               HBPLAY    143
  51  JNL = N+1                                                              HBPLAY    144
      IF  (LTEST.EQ.0)  GO TO 79                                             HBPLAY    145
C                                                                            HBPLAY    146
C     PRINT NEW POINT ARRAY IF DIFFERENT.                                    HBPLAY    147
C                                                                            HBPLAY    148
  52  NPTS = LL - L1                                                         HBPLAY    149
      USEC = 1000.0*TIME                                                     HBPLAY    150
      WRITE  (6,53)  USEC,NH,NB,NPTS,NTHRNS(NB)                              HBPLAY    151
  53  FORMAT ("0 HBPLAY TIME =",F10.3," MSEC. NH,NB,NPTS NT=",4I6)           HBPLAY    152
      WRITE  (6,54)  (NL(1,J),J=L2,LL)                                       HBPLAY    153
  54  FORMAT ("  NL(1)=",15I8/(8X,15I8))                                     HBPLAY    154
      WRITE  (6,55)  (BB(J),J=L2,L3)                                         HBPLAY    155
  55  FORMAT ("  BB   =",6X,14F8.3/(6X,15F8.3))                              HBPLAY    156
  79  K1 = K2 + 1                                                            HBPLAY    157
  80  NPTPLY(NB) = LL - L1                                                   HBPLAY    158
      J1 = J2 + 1                                                            HBPLAY    159
  90  CONTINUE                                                               HBPLAY    160
  99  RETURN                                                                 HBPLAY    161
      END                                                                    HBPLAY    162
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CDECK OUTPUT                                                            OUTPUT       2
      SUBROUTINE OUTPUT(IJK)                                            OUTPUT       3
C                                                     REV 21 03/16/81  GBDATE      11
C     CONTROLS TABULATED OUTPUT ON FORTRAN UNITS (STARTING WITH NO. 21) OUTPUT       5
C     OF SELECTED OPTIONAL SEGMENT LINEAR AND ANGULAR ACCELERATIONS,   OUTPUT       6
C     VELOCITIES AND DISPLACEMENTS, JOINT PARAMETERS AND SELECTED DATA OUTPUT       7
C     FROM ALL ALLOWED CONTACT FORCE COMPUTATIONS BETWEEN BODY SEGMENTS OUTPUT       8
C     AND VEHICLE COMPONENTS.                                           OUTPUT       9
C                                                                       OUTPUT      10
      COMMON/CONTRL/ TIME,NSEG,NJNT,NPL,NBLT,NBAG,NVEH,NGRND,           CONTRL       2
     *               NS,NQ,NSD,NFLX,NHRNSS,NWINDF,NJNTF,NPRT(36)        CONTRL       3
      COMMON/SGMNTS/ D(3,3,30),WMEG(3,30),WMEGD(3,30),U1(3,30),U2(3,30), SGMNTS      2
     *               SEGLP(3,30),SEGLV(3,30),SEGLA(3,30),NSYM(30)       SGMNTS       3
      COMMON/DESCRP/ PHI(3,30),W(30),RW(30),SR(3,60),HA(3,60),HB(3,60), DESCRP       2
     *               RPHI(3,30),HT(3,3,60),SPRING(5,90),VISC(7,90),     DESCRP       3
     *               JNT(30),IPIN(30),ISING(30),IGLOB(30),JOINTF(30)    DESCRP       4
      COMMON/JBARTZ/ MNPL(   30),MNBLT(   8),MNSEG(   30),MNBAG(    6),  JBARTZ       2
     *               MPL(3,5,30),MBLT(3,5,8),MSEG(3,5,30),MBAG(3,10,6), JBARTZ       3
     *               NTPL( 5,30),NTBLT( 5,8),NTSEG( 5,30)               JBARTZ       4
      COMMON/TITLES/ DATE(3),COMENT(40),VPSTTL(20),BDYTTL(5),           TITLES       2
     *               BLTTTL(5,8),PLTTL(5,30),BAGTTL(5,6),SEG(30),       TITLES       3
     *               JOINT(30),CGS(30),JS(30)                           TITLES       4
      REAL DATE,COMENT,VPSTTL,BDYTTL,BLTTTL,PLTTL,BAGTTL,SEG,JOINT      TITLES       5
      LOGICAL   CGS,JS                                                  TITLES       6
      COMMON/FORCES/ PSF(7,30),BSF(4,20),SSF(10,20),BAGSF(3,20),        FORCES       2
     *               PRJNT(7,30),NPANEL(5),NPSF,NBSF,NSSF,NBGSF         FORCES       3
      COMMON/CNSNTS/ PI,RADIAN,G,THIRD,EPS(24),                         CNSNTS       2
     *               UNITL,UNITM,UNITT,GRAVTY(3)                        CNSNTS       3
      COMMON/RSAVE/  XSG(3,20,3),DPMI(3,3,30),LPMI(30),                 GB08JUN82    1
     *               NSG(7),MSG(20,7),MCG,MCGIN(24,5)                   GB08JUN82    2
      COMMON/COMAIN/ VAR(240),DER(240),DT,H0,HMAX,HMIN,RSTIME,          COMAIN       2
     *               ISTEP,NSTEPS,NDINT,NEQ,IRSIN,IRSOUT                COMAIN       3
      COMMON/DAMPER/ APSDM(3,20),APSDN(3,20),ASD(5,20),MSDM(20),MSDN(20) DAMPER      2
      COMMON/HRNESS/ BAR(15,100),BB(100),BBDOT(100),PLOSS(2,100),       HRNESS       2
     *               XLONG(20),HTIME(2),IBAR(5,100),NL(2,100),          HRNESS       3
     *               NPTSPB(20),NPTPLY(20),NTHRNS(20),NBLTPH(5)         HRNESS       4
      COMMON/TEMPVS/ TDATA(14,50),ACC(7,20),T1(3),T2(3),T3(3),T4(9)     OUTPUT      37
      LOGICAL  LTAPE8 , LTHIST                                          OUTPUT      38
      DATA LINES/-1/,LPP/45/                                            GB08JUN82  118
C                                                                       OUTPUT      40
      IF (IJK.NE.0) GO TO 13                                            OUTPUT      41
C                                                                       OUTPUT      42
C     SET ALL FORCE ARRAYS TO ZERO.                                     OUTPUT      43
C                                                                       OUTPUT      44
      DO  11  I=1,760                                                   OUTPUT      45
   11 PSF(I,1) = 0.0                                                    OUTPUT      46
      GO TO 66                                                          OUTPUT      47
C                                                                       OUTPUT      48
C     LTHIST = TRUE MEANS PRINT LINE OF TIME HISTORY DATA FOR THIS      OUTPUT      49
C                          TIME POINT ON EACH OUTPUT UNIT (NT).         OUTPUT      50
C                                                                       OUTPUT      51
C     LTAPE8 = TRUE MEANS WRITE TIME HISTORY DATA ON TAPE 8.            OUTPUT      52
C                                                                       OUTPUT      53
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   13 NPRT4 = NPRT(4) + 4                                                    OUTPUT      54
      IF  (NPRT4.LE.0 .OR. NPRT4.GT.8)  STOP 37                              OUTPUT      55
      LTHIST = .TRUE.                                                        GB16MAR81   26
      LTAPE8 = .FALSE.                                                       GB16MAR81   27
      GO TO  (66,66,66,16,15,14,14,15) , NPRT4                               OUTPUT      56
   14 LTHIST = .FALSE.                                                       OUTPUT      57
      LTAPE8 = .TRUE.                                                        OUTPUT      58
      GO TO 17                                                               OUTPUT      59
   15 LTAPE8 = .TRUE.                                                        GB16MAR81   28
   16 TEST = AMOD(TIME,DT)                                                   GB16MAR81   29
      TEST = AMIN1(TEST,ABS(DT-TEST))                                        GB16MAR81   30
      IF (NPRT(26).EQ.0 .AND. TEST.GT.EPS(7)) LTHIST = .FALSE.               GB16MAR81   31
      IF  (.NOT.LTAPE8 .AND. .NOT.LTHIST)  GO TO 66                          GB08JUN82  119
   17 CALL ELTIME (1,8)                                                      GB08JUN82  120
      IF  (LINES.GE.0)  GO TO 21                                             GB08JUN82  121
      LINES = 0                                                              GB08JUN82  122
      PREVT = -999.0                                                         OUTPUT      67
      IF  (IRSIN.NE.0)  GO TO 10                                             OUTPUT      68
C                                                                            OUTPUT      69
C     1ST TIME IN ROUTINE, READ CARD INPUT FOR OUTPUT CONTROL.               OUTPUT      70
C                                                                            OUTPUT      71
C      1. NO. OF SEGMENT LINEAR  ACCELERATIONS,SEGMENT NOS. AND LOCATION     OUTPUT      72
C      2. NO. OF SEGMENT LINEAR  VELOCITIES   ,SEGMENT NOS. AND LOCATION     OUTPUT      73
C      3. NO. OF SEGMENT LINEAR  DISPLACEMENTS,SEGMENT NOS. AND LOCATION     OUTPUT      74
C      4. NO. OF SEGMENT ANGULAR ACCELERATIONS AND SEGMENT NOS.              OUTPUT      75
C      5. NO. OF SEGMENT ANGULAR VELOCITIES    AND SEGMENT NOS.              OUTPUT      76
C      6. NO. OF SEGMENT ANGULAR DISPLACEMENTS AND SEGMENT NOS.              OUTPUT      77
C      7. NO. OF JOINT PARAMETERS AND JOINT NOS.                             OUTPUT      78
C                                                                            OUTPUT      79
      DO 20 K=1,7                                                            OUTPUT      80
C                                                                            OUTPUT      81
C     INPUT CARDS H.(K).(J) FOR K=1,3                                        OUTPUT      82
C                                                                            OUTPUT      83
      IF (K.LE.3) READ (5,18) KSG,(MSG(J,K),(XSG(I,J,K),I=1,3),J=1,KSG)      OUTPUT      84
   18 FORMAT(2I6,3F12.6/(I12,3F12.6))                                        OUTPUT      85
C                                                                            OUTPUT      86
C     INPUT CARDS H.(K)      FOR K=4,7                                       OUTPUT      87
C                                                                            OUTPUT      88
      IF (K.GT.3) READ (5,19) KSG,(MSG(J,K),J=1,KSG)                         OUTPUT      89
   19 FORMAT(12I6/(I12,10I6))                                                OUTPUT      90
      WRITE  (6,78)  K,KSG,(MSG(J,K),J=1,KSG)                                GB16MAR81   32
   78 FORMAT (" CARD H.",I1,I3,3X,20I3)                                      GB16MAR81   33
      IF (K.NE.7 .OR. KSG.EQ.0) GO TO 20                                     OUTPUT      91
      DO 12 J=1,KSG                                                          OUTPUT      92
      L = MSG(J,K)                                                           OUTPUT      93
      IF (IABS(IPIN(L)).EQ.4) MSG(J,K) = -L                                  OUTPUT      94
   12 CONTINUE                                                               OUTPUT      95
   20 NSG(K) = KSG                                                           OUTPUT      96
C                                                                            GB08JUN82  123
C     READ INPUT CARDS H.8                                                   GB08JUN82  124
C                                                                            GB08JUN82  125
      READ (5,111) MCG                                                       GB08JUN82  126
  111 FORMAT(I6)                                                             GB08JUN82  127
      IF  (MCG.EQ.0)  GO TO 114                                              GB08JUN82  128
```

```
      DO  113  K=1,MCG                                                 GB08JUN82 129
      READ (5,112) M,N,(MCGIN(I+2,K),I=1,N)                            GB08JUN82 130
  112 FORMAT(24I3)                                                     GB08JUN82 131
      MCGIN(1,K) = M                                                   GB08JUN82 132
  113 MCGIN(2,K) = N                                                   GB08JUN82 133
  114 CONTINUE                                                         GB08JUN82 134
   10 IF  (.NOT.LTAPE8)  GO TO 21                                      OUTPUT    97
      WRITE  (8)         NSEG,NJNT,NPL,NBLT,NBAG,NVEH,NGRND,NPANEL,    OUTPUT    98
     *                   MNPL,MNBLT,MNSEG,MNBAG,MPL,MBLT,MSEG,MBAG     OUTPUT    99
      WRITE  (8)         DATE,COMENT,VPSTTL,BDYTTL,BLTTTL,PLTTL,BAGTTL, OUTPUT  100
     *                   SEG,JOINT,UNITL,UNITM,UNITT,NSG,MSG,XSG,MCG,  GB08JUN82 135
     *                   MCGIN,NHRNSS,NBLTPH,NPTSPB,NSD,MSDM,MSDN      GB08JUN82 136
   21 IF  (LTHIST)  LINES = LINES + 1                                  GB08JUN82 137
      IF  (MOD(LINES,LPP).EQ.1 .AND. LTHIST)  CALL HEDING (LINES,LPP)  OUTPUT   104
      NT = 20                                                          OUTPUT   105
      USEC = 1000.0*TIME                                               OUTPUT   106
C                                                                      OUTPUT   107
C     COMPUTE AND PRINT DATA FOR 7 TYPES OF OUTPUT ABOVE               OUTPUT   108
C                                                                      OUTPUT   109
      DO 44 K=1,7                                                      OUTPUT   110
      IF (NSG(K).LE.0) GO TO 44                                        OUTPUT   111
      KSG = NSG(K)                                                     OUTPUT   112
      J3  = 3                                                          OUTPUT   113
      IF (K.EQ.7) J3 = 2                                               OUTPUT   114
      DO 43 J1=1,KSG,J3                                                OUTPUT   115
      J2 = MIN0(J1+J3-1,KSG)                                           OUTPUT   116
      NT = NT+1                                                        OUTPUT   117
      DO 38 J=J1,J2                                                    OUTPUT   118
      L = IABS(MSG(J,K))                                               OUTPUT   119
      GO TO (22,24,26,29,31,34,35),K                                   OUTPUT   120
C                                                                      OUTPUT   121
C     1. SEGMENT LINEAR ACCELERATIONS IN LOCAL REFERENCE               OUTPUT   122
C                                                                      OUTPUT   123
   22 CALL CROSS (WMEG(1,L),XSG(1,J,K),T1)                             OUTPUT   124
      CALL CROSS (WMEG(1,L),T1,T2)                                     OUTPUT   125
      CALL CROSS (WMEGD(1,L),XSG(1,J,K),T3)                            OUTPUT   126
      CALL MAT31(D(1,1,L),SEGLA(1,L),T4)                               OUTPUT   127
      DO 23 I=1,3                                                      OUTPUT   128
      ACC(I,J) = (T4(I)+T3(I)+T2(I))/G                                 OUTPUT   129
   23 T1(I) = ACC(I,J)                                                 OUTPUT   130
      IF  (LPMI(L).NE.0)  CALL DOT31 (DPMI(1,1,L),T1,ACC(1,J))         OUTPUT   131
      GO TO 33                                                         OUTPUT   132
C                                                                      OUTPUT   133
C     2. SEGMENT LINEAR VELOCITIES IN VEHICLE REFERENCE                OUTPUT   134
C                                                                      OUTPUT   135
   24 CALL CROSS (WMEG(1,L),XSG(1,J,K),T1)                             OUTPUT   136
      CALL DOT31(D(1,1,L),T1,T2)                                       OUTPUT   137
      DO 25 I=1,3                                                      OUTPUT   138
   25 T3(I) = T2(I) + SEGLV(I,L) - SEGLV(I,NVEH)                       OUTPUT   139
      GO TO 28                                                         OUTPUT   140
C                                                                      OUTPUT   141
C     3. SEGMENT LINEAR DISPLACEMENTS IN VEHICLE REFERENCE             OUTPUT   142
C                                                                      OUTPUT   143
   26 IF  (LPMI(L).EQ.0)  GO TO 76                                     OUTPUT   144
```

```
      CALL DOT33 (DPMI(1,1,L),D(1,1,L),T4)
      CALL DOT31 (T4,XSG(1,J,K),T1)
      GO TO 77
   76 CALL DOT31 (D(1,1,L),XSG(1,J,K),T1)
   77 DO 27 I=1,3
   27 T3(I) = T1(I) + SEGLP(I,L) - SEGLP(I,NVEH)
   28 CALL MAT31 (D(1,1,NVEH),T3,ACC(1,J))
      GO TO 33
C
C     4. SEGMENT ANGULAR ACCELERATIONS IN LOCAL REFERENCE
C
   29 DO 30 I=1,3
      ACC(I,J) = WMEGD(I,L)/(2.0*PI)
   30 T1(I) = ACC(I,J)
      IF  (LPMI(L).NE.0)  CALL DOT31 (DPMI(1,1,L),T1,ACC(1,J))
      GO TO 33
C
C     5. SEGMENT ANGULAR VELOCITIES IN VEHICLE REFERENCE
C
   31 CALL DOT31 (D(1,1,L),WMEG(1,L),T1)
      CALL MAT31 (D(1,1,NVEH),T1,T2)
      DO 32 I=1,3
   32 ACC(I,J) = (T2(I)-WMEG(I,NVEH))/(2.0*PI)
   33 ACC(4,J) =  SQRT(ACC(1,J)**2+ACC(2,J)**2+ACC(3,J)**2)
      GO TO 38
C
C     6. SEGMENT ANGULAR DISPLACEMENTS IN VEHICLE REFERENCE
C
   34 IF  (LPMI(L).EQ.0)  GO TO 36
      CALL DOT33(DPMI(1,1,L),D(1,1,L),T4)
      CALL DOTT33(T4,D(1,1,NVEH),T1)
      GO TO 37
   36 CALL DOTT33 (D(1,1,L),D(1,1,NVEH),T1)
   37 CALL YPRDEG(T1,ACC(1,J))
      TRACE = 0.5*(T1(1)+T2(2)+T3(3)-1.0)
      IF (TRACE.GT. 1.0) TRACE =  1.0
      IF (TRACE.LT.-1.0) TRACE = -1.0
      ACC(4,J) =   ACOS(TRACE)/RADIAN
      GO TO 38
C
C     7. JOINT PARAMETERS
C
   35 ACC(1,J) = PRJNT(1,L)
      ACC(2,J) = PRJNT(2,L)/RADIAN
      ACC(3,J) = PRJNT(3,L)/RADIAN
      ACC(4,J) = PRJNT(4,L)/RADIAN
      ACC(5,J) =  SQRT(PRJNT(5,L))
      ACC(6,J) =  SQRT(PRJNT(6,L))
      ACC(7,J) =  SQRT(PRJNT(7,L))
   38 CONTINUE
      IF  (.NOT.LTAPE8)  GO TO 40
      KK = 0
      I2 = 4
      IF  (K.EQ.7)  I2 = 7
```

```
      DO  39  J=J1,J2                                                   OUTPUT   199
      DO  39  I=1,I2                                                    OUTPUT   200
      KK = KK+1                                                         OUTPUT   201
   39 TDATA(KK,NT-20) = ACC(I,J)                                        OUTPUT   202
   40 IF  (.NOT.LTHIST)  GO TO 43                                       OUTPUT   203
      IF (K.LE.6) WRITE (NT,41) USEC,((ACC(I,J),I=1,4),J=J1,J2)         OUTPUT   204
   41 FORMAT(F9.3,3(3X,4F9.3) )                                         OUTPUT   205
      IF (K.EQ.7) WRITE (NT,42) USEC,((ACC(I,J),I=1,7),J=J1,J2)         OUTPUT   206
   42 FORMAT(F9.3,2(F5.0,3F9.3,2X,3F9.3))                               OUTPUT   207
   43 CONTINUE                                                          OUTPUT   208
   44 CONTINUE                                                          OUTPUT   209
C                                                                       GB08JUN82 138
C     PRINT BODY PROPERTIES CONTROLLED BY CARDS H.8                     GB08JUN82 139
C                                                                       GB08JUN82 140
      IF  (MCG.EQ.0)  GO TO 131                                         GB08JUN82 141
      DO  130  NCG=1,MCG                                                GB08JUN82 142
      M = MCGIN(1,NCG)                                                  GB08JUN82 143
      N = MCGIN(2,NCG)                                                  GB08JUN82 144
      DO  120  J=1,9                                                    GB08JUN82 145
  120 T4(J) = 0.0                                                       GB08JUN82 146
      SUMW  = 0.0                                                       GB08JUN82 147
      DO  123  I=1,N                                                    GB08JUN82 148
      K = MCGIN(I+2,NCG)                                                GB08JUN82 149
      WG = W(K)/G                                                       GB08JUN82 150
      SUMW = SUMW + WG                                                  GB08JUN82 151
      DO  121  J=1,3                                                    GB08JUN82 152
  121 T1(J) = PHI(J,K)*WMEG(J,K)                                        GB08JUN82 153
      CALL DOT31 (D(1,1,K),T1,T2)                                       GB08JUN82 154
      CALL CROSS (SEGLP(1,K),SEGLV(1,K),T1)                             GB08JUN82 155
      DO  122  J=1,3                                                    GB08JUN82 156
      T4(J  ) = T4(J  ) + WG*SEGLP(J,K)                                 GB08JUN82 157
      T4(J+3) = T4(J+3) + WG*SEGLV(J,K)                                 GB08JUN82 158
  122 T4(J+6) = T4(J+6) + WG*T1(J) + T2(J)                              GB08JUN82 159
  123 CONTINUE                                                          GB08JUN82 160
      DO  124  J=1,3                                                    GB08JUN82 161
  124 T4(J) = T4(J)/SUMW - SEGLP(J,M)                                   GB08JUN82 162
      CALL MAT31 (D(1,1,M),T4(1),T1)                                    GB08JUN82 163
      CALL MAT31 (D(1,1,M),T4(4),T2)                                    GB08JUN82 164
      CALL MAT31 (D(1,1,M),T4(7),T3)                                    GB08JUN82 165
      NT = NT + 1                                                       GB08JUN82 166
      IF  (.NOT.LTAPE8)  GO TO 126                                      GB08JUN82 167
      DO  125  J=1,3                                                    GB08JUN82 168
      TDATA(J  ,NT-20) = T1(J)                                          GB08JUN82 169
      TDATA(J+3,NT-20) = T2(J)                                          GB08JUN82 170
  125 TDATA(J+6,NT-20) = T3(J)                                          GB08JUN82 171
  126 IF  (LTHIST)  WRITE (NT,127) USEC,T1,T2,T3                        GB08JUN82 172
  127 FORMAT (F9.3,3X,3F9.3,3X,3F12.0,3X,3F12.0)                        GB08JUN82 173
  130 CONTINUE                                                          GB08JUN82 174
  131 CONTINUE                                                          GB08JUN82 175
C                                                                       OUTPUT   210
C     PRINT PLANE FORCES                                                OUTPUT   211
C                                                                       OUTPUT   212
      MPSF = 0                                                          OUTPUT   213
      IF  (NPL.EQ.0)  GO TO 49                                          OUTPUT   214
```

```
      DO  45  J=1,NPL
   45 MPSF = MPSF + MNPL(J)
      IF  (MPSF.EQ.0)  GO TO 49
      DO 47 J1=1,MPSF,2
      J2 = MIN0(J1+1,MPSF)
      NT = NT+1
      IF  (.NOT.LTAPE8)  GO TO 47
      KK = 0
      DO  46  J=J1,J2
      DO  46  I=1,7
      KK = KK+1
   46 TDATA(KK,NT-20) = PSF(I,J)
   47 IF  (LTHIST)  WRITE (NT,48) USEC,((PSF(I,J),I=1,7),J=J1,J2)
   48 FORMAT(F9.3,2(F9.3,3F9.2,3F8.3) )
C
C     PRINT BELT FORCES
C
   49 MBSF = 0
      IF  (NBLT.EQ.0)  GO TO 67
      DO  50  J=1,NBLT
   50 MBSF = MBSF + MNBLT(J)
      IF  (MBSF.EQ.0)  GO TO 67
      DO 52 J1=1,MBSF,2
      J2 = MIN0(J1+1,MBSF)
      NT = NT+1
      IF  (.NOT.LTAPE8)  GO TO 52
      KK = 0
      DO  51  J=J1,J2
      DO  51  I=1,4
      KK = KK+1
   51 TDATA(KK,NT-20) = BSF(I,J)
   52 IF  (LTHIST)  WRITE (NT,53) USEC,((BSF(I,J),I=1,4),J=J1,J2)
   53 FORMAT(F9.3,4(F15.6,F12.2,3X) )
C
C     PRINT HARNESS-BELT ENDPOINT FORCES (STORED IN BSF ARRAY).
C
   67 IF  (NHRNSS.LE.0)  GO TO 71
      MBSF1 = MBSF + 1
      DO  68  I=1,NHRNSS
   68 MBSF = MBSF + NBLTPH(I)
      DO  70  J1=MBSF1,MBSF,2
      J2 = MIN0(J1+1,MBSF)
      NT = NT+1
      IF  (.NOT.LTAPE8)  GO TO 70
      KK = 0
      DO  69  J=J1,J2
      DO  69  I=1,4
      KK = KK+1
   69 TDATA(KK,NT-20) = BSF(I,J)
   70 IF  (LTHIST)  WRITE (NT,53) USEC,((BSF(I,J),I=1,4),J=J1,J2)
C
C     PRINT SPRING DAMPER FORCES (STORED IN BSF ARRAY).
C
   71 IF  (NSD.LE.0)  GO TO 54
```

```
      MBSF1 = MBSF + 1
      MBSF = MBSF + (NSD+1)/2
      DO  73  J1=MBSF1,MBSF,2
      J2 = MIN0(J1+1,MBSF)
      NT = NT+1
      IF  (.NOT.LTAPE8)  GO TO 73
      KK = 0
      DO  72  J=J1,J2
      DO  72  I=1,4
      KK = KK+1
   72 TDATA(KK,NT-20) = BSF(I,J)
   73 IF  (LTHIST)  WRITE (NT,74) USEC,((BSF(I,J),I=1,4),J=J1,J2)
   74 FORMAT (F9.3,4(F14.3,F12.2,4X))
C
C     PRINT SEGMENT CONTACT FORCES
C
   54 MSSF = 0
      DO  55  J=1,NSEG
   55 MSSF = MSSF + MNSEG(J)
      IF  (MSSF.EQ.0)  GO TO 59
      DO 57 J=1,MSSF
      NT = NT+1
      IF  (.NOT.LTAPE8)  GO TO 57
      DO  56  I=1,10
   56 TDATA(I,NT-20) = SSF(I,J)
   57 IF  (LTHIST)  WRITE (NT,58) USEC,(SSF(I,J),I=1,10)
   58 FORMAT(2F9.3,3F9.2,3F8.3,2X,3F8.3)
C
C     PRINT AIRBAG FORCES
C
   59 IF (NBAG.EQ.0) GO TO 65
      K1 = 1
      DO 64 J=1,NBAG
      IF (MNBAG(J).EQ.0) GO TO 64
      KBAG = MNBAG(J)+NPANEL(J)+5
      DO 63 J1=1,KBAG,4
      J2 = MIN0(J1+3,KBAG)
      K2 = K1+J2-J1
      NT = NT+1
      IF  (.NOT.LTAPE8)  GO TO 61
      KK = 0
      DO  60  K=K1,K2
      DO  60  I=1,3
      KK = KK+1
   60 TDATA(KK,NT-20) = BAGSF(I,K)
   61 IF  (.NOT.LTHIST)  GO TO 63
      IF  (J1.EQ.1)  WRITE (NT,75) USEC,((BAGSF(I,K),I=1,3),K=K1,K2)
      IF  (J1.NE.1)  WRITE (NT,62) USEC,((BAGSF(I,K),I=1,3),K=K1,K2)
   75 FORMAT (F9.3,3X,3F9.2,2(3X,3F9.3),3X,3F9.2)
   62 FORMAT(F9.3,4(3X,3F9.2))
   63 K1 = K2+1
   64 CONTINUE
   65 NT = NT-20
      IF  (LTAPE8)  WRITE (8) NT,USEC,((TDATA(I,J),I=1,14),J=1,NT)
```

```
      PREVT = TIME
      CALL ELTIME(2,8)
   66 RETURN
      END
```

```
CDECK PLELP                                                             PLELP       2
      SUBROUTINE PLELP (M,MMM,N,NN,NT)                                  GB08JUN82 176
C                                                    REV 21 06/08/82    GB08JUN82 177
C     COMPUTES FORCES (WHICH ARE ADDED TO U1 ARRAY)                     PLELP       5
C      AND TORQUES    (WHICH ARE ADDED TO U2 ARRAY)                     PLELP       6
C     OF ELLIPSOID (MM) ATTACHED TO BODY SEGMENT (M)                    PLELP       7
C     INTERSECTING PLANE (NN) ATTACHED TO SEGMENT (N).                  PLELP       8
C                                                                       PLELP       9
      COMMON/TABLES/ MXNTI,MXNTB,MXTB1,MXTB2,NTI(50),NTAB(500),TAB(2600) TABLES     2
      COMMON/SGMNTS/ D(3,3,30),WMEG(3,30),WMEGD(3,30),U1(3,30),U2(3,30), SGMNTS     2
     *               SEGLP(3,30),SEGLV(3,30),SEGLA(3,30),NSYM(30)       SGMNTS      3
      COMMON/FORCES/ PSF(7,30),BSF(4,20),SSF(10,20),BAGSF(3,20),        FORCES      2
     *               PRJNT(7,30),NPANEL(5),NPSF,NBSF,NSSF,NBGSF         FORCES      3
      COMMON/CNTSRF/ PL(17,30),BELT(20,8),TPTS(6,8),BD(24,40)           CNTSRF      2
      COMMON/CSTRNT/ A13(3,3,24),A23(3,3,24),B31(3,3,24),B32(3,3,24),   CSTRNT      2
     *               HHT(3,3,12),RK1(3,12),RK2(3,12),QQ(3,12),TQQ(3,12), CSTRNT     3
     *               RQQ(3,12),HQQ(3,12),SQQ(12),CFQQ(12),              CSTRNT      4
     *               KQ1(12),KQ2(12),KQTYPE(12)                         CSTRNT      5
C     THIS COMMON/TEMPVS/ IS SHARED BY PLELP, PLSEGF AND SEGSEG.        TMPVSP      2
      COMMON/TEMPVS/DMNT(3,3),TEMP(3,3),B(3,3),XMN(3),RLN(3),XMM(3),    TMPVSP      3
     *              TM(3),R(3),RM(3),DMNWN(3),RLM(3),RN(3),VMN(3),VR(3), TMPVSP     4
     *              WMN(3),WCM(3),WCN(3),VREL(3),FFM(3),FR(3),TQM(3),   TMPVSP      5
     *              TQN(3),TQNT(3),T(3),H(3),T1(3),T2(3),RMD(3),RND(3), TMPVSP      6
     *              TD(3),TT4(3,4),TT5(3,4),T3(3),T4(3),P,AMR,FM,CF,    TMPVSP      7
     *              VRM,VRT,VRTS,VRTEST,TF,ELOSS,MCF,NCF                TMPVSP      8
      CALL ELTIME(1,21)                                                 PLELP      27
      MM = IABS(MMM)                                                    GB08JUN82 178
C                                                                       PLELP      28
C     COMPUTE PENETRATION DISTANCE, IF NEGATIVE, RETURN.                PLELP      29
C                                                                       PLELP      30
      CALL DOTT33(D(1,1,M),D(1,1,N),DMNT)                               PLELP      31
      DO 10 I=1,3                                                       PLELP      32
   10 XMN(I) = SEGLP(I,M) - SEGLP(I,N)                                  PLELP      33
      CALL MAT31(D(1,1,M),XMN,XMM)                                      PLELP      34
      CALL MAT31(DMNT,PL(1,NN),TM)                                      PLELP      35
      BET = PL(4,NN)                                                    PLELP      36
      DO 11 I=1,3                                                       PLELP      37
   11 BET = BET - TM(I)*(BD(I+3,MM)+XMM(I))                             PLELP      38
      CALL MAT31(BD(16,MM),TM,T4)                                       PLELP      39
      BTS = TM(1)*T4(1) + TM(2)*T4(2) + TM(3)*T4(3)                     PLELP      40
      BTE = - SQRT(BTS)                                                 PLELP      41
      P = BET - BTE                                                     PLELP      42
      PSF(1,NPSF) = P                                                   PLELP      43
      MCF = NTAB(NT+1)                                                  PLELP      44
      NCF = -MCF                                                        PLELP      45
      IF (NCF.GT.0) CFQQ(NCF) = -999.                                   PLELP      46
      IF (P.LE.0.0) GO TO 99                                            PLELP      47
C                                                                       PLELP      48
C     IF COMPLETE PENETRATION, RETURN                                   PLELP      49
C                                                                       PLELP      50
      IF (BET+BTE.GT.0.0) GO TO 99                                      PLELP      51
C                                                                       GB08JUN82 179
C     NOTE: THE THREE "GO TO 99" STATEMENTS CAN BE IDENTIFIED IN THE    GB08JUN82 180
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C           TABULAR TIME HISTORIES (ALL WITH ZERO FORCES) AS FOLLOWS:    GB08JUN82 181
C                                                                        GB08JUN82 182
C        A. IF THE PENETRATION IS NEGATIVE (LOCATION WILL BE ZERO),      GB08JUN82 183
C           THEN THE ELLIPSOID HAS NOT CONTACTED THE INFINITE PLANE.     GB08JUN82 184
C                                                                        GB08JUN82 185
C        B. IF THE PENETRATION IS POSITIVE AND THE LOCATION IS ZERO,     GB08JUN82 186
C           THEN THE ELLIPSOID HAS COMPLETELY PENETRATED THE INFINITE    GB08JUN82 187
C           PLANE AND ZERO FORCES ARE ASSUMED.                           GB08JUN82 188
C                                                                        GB08JUN82 189
C        C. IF THE PENETRATION IS POSITIVE AND THE LOCATION IS NOT ZERO, GB08JUN82 190
C           THEN POINT OF CONTACT AT WHICH THE FORCES ARE TO BE APPLIED  GB08JUN82 191
C           FALLS OUTSIDE THE FINITE PLANE DEFINED ON CARDS D.2.         GB08JUN82 192
C                                                                        GB08JUN82 193
C                                                                        PLELP      52
C     COMPUTE TG - THE POINT IN SEGMENT REFERENCE AT WHICH THE CONTACT   PLELP      53
C                  FORCES ARE TO BE APPLIED WHICH LIES ON THE SCALED     PLELP      54
C                  LINE BETWEEN THE POINT OF MAXIMUM PENETRATION (RHO=0) PLELP      55
C                  AND THE CENTER OF THE INTERSECTION ELLIPSE (RHO=1).   PLELP      56
C       AND TEMP - THE SAME POINT IN VEHICLE REFERENCE.                  PLELP      57
C                                                                        PLELP      58
      RHO = 0.0                                                          PLELP      59
      IF (MCF.GT.0) RHO = TAB(MCF+4)                                     PLELP      60
      BETE = (1.0+RHO*P/BTE)/BTE                                         PLELP      61
      AMR  = -1.0/BTE                                                    PLELP      62
      DO 13 I=1,3                                                        PLELP      63
      RM(I) = BETE*T4(I)                                                 PLELP      64
      RLM(I) = RM(I) + BD(I+3,MM)                                        PLELP      65
   13 RN(I)  = RLM(I) + XMM(I)                                           PLELP      66
      CALL DOT31(DMNT,RN,RLN)                                            PLELP      67
      DO  24  I=1,3                                                      GB08JUN82 194
      PSF(I+4,NPSF) = RLN(I)                                             GB08JUN82 195
   24 IF  (MMM.LT.0)  PSF(I+4,NPSF) = RLM(I)                             GB08JUN82 196
C                                                                        PLELP      68
C     IF BOUNDARY PLANE IS GIVEN, COMPUTE DISTANCE FROM POINT TO PLANE,  PLELP      69
C         IF NEGATIVE OR > LIMIT, RETURN.                                PLELP      70
C                                                                        PLELP      71
      DO 14 I=8,13,5                                                     PLELP      72
      IF (PL(I+4,NN).LE.0.0) GO TO 14                                    PLELP      73
      DIST = RLN(1)*PL(I  ,NN)                                           PLELP      74
     *     + RLN(2)*PL(I+1,NN)                                           PLELP      75
     *     + RLN(3)*PL(I+2,NN) - PL(I+3,NN)                              PLELP      76
      IF (DIST.LE.0.0 .OR. DIST.GT.PL(I+4,NN)) GO TO 99                  PLELP      77
   14 CONTINUE                                                           PLELP      78
      CALL PLSEGF(M,N,NT)                                                PLELP      79
      IF (MCF.LT.0) GO TO 30                                             PLELP      80
C                                                                        PLELP      81
C     STORE RESULTS FOR OUTPUT ROUTINE.                                  PLELP      82
C                                                                        PLELP      83
      PSF(2,NPSF) = FM                                                   PLELP      84
      TF2FM2 = TF**2 - FM**2                                             PLELP      85
      IF (TF2FM2.LE.0.0) TF2FM2 = 0.0                                    PLELP      86
      PSF(3,NPSF) =  SQRT(TF2FM2)                                        PLELP      87
      PSF(4,NPSF) = TF                                                   PLELP      88
      GO TO 99                                                           PLELP      91
```

```
30 DO 31 I=1,3                                          PLELP
   PSF(I+1,NPSF) = T(I)                                 PLELP
31 PSF(I+4,NPSF) = RLN(I)                               PLELP
   CALL CROSS(WMN,TM,T1)                                PLELP
   CALL MAT31(BD(16,MM),T1,T2)                          PLELP
   TMT = TM(1)*T2(1) + TM(2)*T2(2) + TM(3)*T2(3)        PLELP
   TMT = TMT/BTS                                        PLELP
   TRT = RHO*(VRM+P*TMT)/BTS                            PLELP
   DO 32 I=1,3                                          PLELP
   T3(I) = VR(I) + VRM*TM(I)                            PLELP
32 RMD(I) = BETE*T2(I) - TMT*RM(I) - TRT*T4(I)          PLELP
   CALL CROSS(DMNWN,T3,T1)                              PLELP
   CALL CROSS(WMN,RMD,T3)                               PLELP
   SQQ(NCF) = 0.0                                       PLELP
   DO 36 I=1,3                                          PLELP
   SQQ(NCF) = SQQ(NCF) + TM(I)*(T3(I)+2.0*T1(I))        PLELP
36 T3(I) = T3(I) + T1(I)                                PLELP
   CALL DOT31(D(1,1,M),T3,RQQ(1,NCF))                   PLELP
99 CALL ELTIME(2,21)                                    PLELP
   RETURN                                               PLELP
   END                                                  PLELP
```

```
CDECK WINDY                                                             WINDY        2
      SUBROUTINE WINDY(M,MM,N,NN,NT)                                    WINDY        3
C                                                     REV 21 04/05/81   GBDATE      20
C     COMPUTES FORCES AND TORQUES ADDING THEM TO THE U1 AND U2 ARRAYS   WINDY        5
C     OF WIND BLAST FORCES DETERMINED BY FUNCTION STORED IN TAB(NT)     WINDY        6
C     ON ELLIPSOID (MM) ATTACHED TO BODY SEGMENT (M) WHICH EXTENDS      WINDY        7
C     THROUGH THE INTERSECTING PLANE (NN) ATTACHED TO SEGMENT (N).      WINDY        8
C                                                                       WINDY        9
      COMMON/CONTRL/ TIME,NSEG,NJNT,NPL,NBLT,NBAG,NVEH,NGRND,           CONTRL       2
     *               NS,NQ,NSD,NFLX,NHRNSS,NWINDF,NJNTF,NPRT(36)        CONTRL       3
      COMMON/SGMNTS/ D(3,3,30),WMEG(3,30),WMEGD(3,30),U1(3,30),U2(3,30), SGMNTS      2
     *               SEGLP(3,30),SEGLV(3,30),SEGLA(3,30),NSYM(30)       SGMNTS       3
      COMMON/TABLES/ MXNTI,MXNTB,MXTB1,MXTB2,NTI(50),NTAB(500),TAB(2600) TABLES      2
      COMMON/WINDFR/ WTIME(30),QFU(3,5),QFV(3,5),QFX(3,5),              GB29APR82    1
     *               IWIND(30),MWSEG(5,30),NFVSEG(6),NFVNT(2,5)         GB29APR82    2
      COMMON/CNTSRF/ PL(17,30),BELT(20,8),TPTS(6,8),BD(24,40)           CNTSRF       2
      COMMON/CNSNTS/ PI,RADIAN,G,THIRD,EPS(24),                         CNSNTS       2
     *               UNITL,UNITM,UNITT,GRAVTY(3)                        CNSNTS       3
      COMMON/DESCRP/ PHI(3,30),W(30),RW(30),SR(3,60),HA(3,60),HB(3,60), DESCRP       2
     *               RPHI(3,30),HT(3,3,60),SPRING(5,90),VISC(7,90),     DESCRP       3
     *               JNT(30),IPIN(30),ISING(30),IGLOB(30),JOINTF(30)    DESCRP       4
      COMMON/ARODAT/ DC(3,3,30),OFFSET(3,30),AREAS(30),REFL(30),        GB12MAY82    2
     *               WIND(3),RHO,TDELAY(10),SSOUND,ICF(18,6,24)         GB12MAY82    3
      COMMON/TEMPVS/ DMNT(3,3),XMN(3),XMM(3),TM(3),BET,BTS,P,FT(3),     WINDY       20
     *               FF(3),AF(3),FAF,TF,BREF,SCALE,TRACER,AREA,RLM(3),  WINDY       21
     *               TQM(3),RM(3)                                       WINDY       22
      CALL ELTIME(1,37)                                                 WINDY       23
      IF  (M.LT.0)  GO TO 50                                            WINDY       24
      IF  (MM.GE.0)  GO TO 20                                           GB12MAY82  193
C                                                                       GB12MAY82  194
C     MM (ELLIPSOID NO.) NEGATIVE: CALCULATE CHUTE FORCES               GB12MAY82  195
C                                                                       GB12MAY82  196
      KT = NTI(NT)                                                      GB12MAY82  197
      CA = EVALFD (TIME,KT,1)                                           GB12MAY82  198
      IF  (CA.EQ.0.0)  GO TO 99                                         GB12MAY82  199
C                                                                       GB12MAY82  200
C     COMPUTE VELOCITY OF SEGMENT M RELATIVE TO WIND                    GB12MAY82  201
C                                                                       GB12MAY82  202
      DO  12  I=1,3                                                     GB12MAY82  203
   12 TM(I) = SEGLV(I,M) - WIND(I)                                      GB12MAY82  204
      V2 = TM(1)**2 + TM(2)**2 + TM(3)**2                               GB12MAY82  205
      K = IABS(MM)                                                      GB12MAY82  206
      AREA = PI*BD(2,K)*BD(3,K)                                         GB12MAY82  207
      FRCE = 0.5*RHO*V2*CA*AREA                                         GB12MAY82  208
      IF  (FRCE.EQ.0.0)  GO TO 99                                       GB12MAY82  209
      VREL = SQRT(V2)                                                   GB12MAY82  210
      DO  13  I=1,3                                                     GB12MAY82  211
   13 TM(I) = TM(I)/VREL                                                GB12MAY82  212
      CALL MAT31 (D(1,1,M),TM,RM)                                       GB12MAY82  213
      RLM(1) = -BD(1,K)                                                 GB12MAY82  214
      RLM(2) = 0.0                                                      GB12MAY82  215
      RLM(3) = 0.0                                                      GB12MAY82  216
```

```
      CALL CROSS (RLM,RM,TQM)                                           GB12MAY82 217
      DO  14  I=1,3                                                     GB12MAY82 218
      U1(I,M) = U1(I,M) - FRCE*TM(I)                                    GB12MAY82 219
   14 U2(I,M) = U2(I,M) - FRCE*TQM(I)                                   GB12MAY82 220
      GO TO 99                                                          GB12MAY82 221
   20 CONTINUE                                                          GB12MAY82 222
C                                                                       WINDY      25
C     COMPUTE PENETRATION DISTANCE; IF NEGATIVE, RETURN.                WINDY      26
C                                                                       WINDY      27
      CALL DOTT33 (D(1,1,M),D(1,1,N),DMNT)                              WINDY      28
      DO 10 I=1,3                                                       WINDY      29
   10 XMN(I) = SEGLP(I,M) - SEGLP(I,N)                                  WINDY      30
      CALL MAT31 (D(1,1,M),XMN,XMM)                                     WINDY      31
      CALL MAT31 (DMNT,PL(1,NN),TM)                                     WINDY      32
      BET = PL(4,NN)                                                    WINDY      33
      DO 11 I=1,3                                                       WINDY      34
   11 BET = BET - TM(I)*(BD(I+3,MM)+XMM(I))                             WINDY      35
      CALL MAT31 (BD(16,MM),TM,RM)                                      WINDY      36
      BTS = TM(1)*RM(1) + TM(2)*RM(2) + TM(3)*RM(3)                     WINDY      37
      BTE = - SQRT(BTS)                                                 WINDY      38
      P   = BET - BTE                                                   WINDY      39
      IF (P.LT.0.0) GO TO 99                                            WINDY      40
C                                                                       WINDY      41
C     FETCH OR STORE INITIAL PENETRATION TIME.                          WINDY      42
C                                                                       WINDY      43
      IWIND(M) = M                                                      WINDY      44
      IF (TIME.LE.WTIME(M)) WTIME(M) = TIME                             WINDY      45
      FTIME = TIME - WTIME(M)                                           WINDY      46
C                                                                       WINDY      47
C     GET FORCE VECTOR FT FROM TABLE NT FOR TIME = FTIME.               WINDY      48
C                                                                       WINDY      49
   22 KT = NTI(NT)                                                      WINDY      50
      NENTRY = TAB(KT+5)                                                WINDY      51
      K1 = KT+10                                                        WINDY      52
      K2 = 4*NENTRY + KT+2                                              WINDY      53
      IF (NENTRY.EQ.1) GO TO 31                                         WINDY      54
      DO 30 K=K1,K2,4                                                   WINDY      55
      IF (FTIME.GT.TAB(K)) GO TO 30                                     WINDY      56
      KK = K                                                            WINDY      57
      R1 = (TAB(K)-FTIME)/(TAB(K)-TAB(K-4))                             WINDY      58
      GO TO 32                                                          WINDY      59
   30 CONTINUE                                                          WINDY      60
   31 KK = K2                                                           WINDY      61
      R1 = 0.0                                                          WINDY      62
   32 R2 = 1.0 - R1                                                     WINDY      63
      DO 33 I=1,3                                                       WINDY      64
      K= KK+I                                                           WINDY      65
   33 FT(I) = R2*TAB(K) + R1*TAB(K-4)                                   WINDY      66
C                                                                       WINDY      67
C     COMPUTE PRESENTED AREA TO WIND FORCE.                             WINDY      68
C                                                                       WINDY      69
      CALL MAT31 (D(1,1,M),FT,FF)                                       WINDY      70
      CALL MAT31 (BD(7,MM),FF,AF)                                       WINDY      71
      FAF = FF(1)*AF(1) + FF(2)*AF(2) + FF(3)*AF(3)                     WINDY      72
```

```
      IF (FAF.LE.0.0) GO TO 99
      TF   = TM(1)*FF(1) + TM(2)*FF(2) + TM(3)*FF(3)
      BREF2 = BTS - TF*TF/FAF
      IF  (BREF2.LT.0.0)  GO TO 99
      BREF = SQRT(BREF2)
      SCALE = (-BET+BREF)/(-BTE+BREF)
      IF (SCALE.GE.1.0) GO TO 99
      IF (SCALE.LT.0.0) SCALE = 0.0
      TRACER = (BD( 7,MM)-AF(1)**2/FAF)*(BD(11,MM)-AF(2)**2/FAF)
     *        + (BD( 7,MM)-AF(1)**2/FAF)*(BD(15,MM)-AF(3)**2/FAF)
     *        + (BD(11,MM)-AF(2)**2/FAF)*(BD(15,MM)-AF(3)**2/FAF)
     *        - (BD( 8,MM)-AF(1)*AF(2)/FAF)**2
     *        - (BD( 9,MM)-AF(1)*AF(3)/FAF)**2
     *        - (BD(12,MM)-AF(2)*AF(3)/FAF)**2
      AREA = (1.0-SCALE**2) * PI /  SQRT(TRACER)
C
C     ADD FORCE AND TORQUES TO U1 AND U2 ARRAYS FOR SEGMENT M.
C
      SCALE = SCALE/BTE
      DO 36 I=1,3
      RLM(I) = RM(I)*SCALE + BD(I+3,MM)
      FT (I) = FT(I)*AREA
   36 FF (I) = FF(I)*AREA
      CALL CROSS (RLM,FF,TQM)
      DO 39 I=1,3
      U1(I,M) = U1(I,M) + FT(I)
   39 U2(I,M) = U2(I,M) + TQM(I)
      IF (NPRT(14).NE.0) WRITE (6,41) TIME,M,P,AREA,FT,TQM
   41 FORMAT(" WIND FORCE",F14.6,I6,2F10.3,3X,3F12.5,3X,3F12.5)
      GO TO 99
C
C     M NEGATIVE: CALCULATE FORCE FONCTIONS
C
   50 NFORCE = NFVSEG(6)
      DO  60  J=1,NFORCE
      NFS = IABS(NFVSEG(J))
      NFT = IABS(NFVNT(1,J))
      KFT = NTI(NFT)
      FRCE = EVALFD (TIME,KFT,1)
      IF  (FRCE.EQ.0.0)  GO TO 60
      IF  (NFVSEG(J).GT.0.)  GO TO 52
C
C     NFVSEG(J) NEGATIVE REPRESENTS A JOINT NUMBER
C
      JFS = IABS(JNT(NFS))
      CALL DOT31 (D(1,1,JFS  ),QFU(1,J),TM)
      CALL MAT31 (D(1,1,NFS+1),TM,TQM)
      DO  51  I=1,3
      U2(I,JFS  ) = U2(I,JFS  ) - FRCE*QFU(I,J)
   51 U2(I,NFS+1) = U2(I,NFS+1) + FRCE*TQM(I)
      GO TO 60
   52 IF  (NFVNT(1,J).GT.0.)  GO TO 57
C
C     NEGATIVE NFVNT(1,J) REPRESENTS THE STAPAC ROCKET
```

```
C
      PRATE = WMEG(1,NFS)*QFX(1,J)
     *      + WMEG(2,NFS)*QFX(2,J)
     *      + WMEG(3,NFS)*QFX(3,J)
      NFT = IABS(NFVNT(2,J))
      KFT = NTI(NFT)
      DF2 = EVALFD (PRATE,KFT,1)
      CALL ROT (DMNT,2,DF2)
      CALL DOT31 (DMNT,QFU(1,J),RLM)
      CALL DOT31 (D(1,1,NFS),RLM,TM)
      CALL CROSS (QFV(1,J),RLM,TQM)
      IF  (NPRT(30).NE.0)  WRITE (6,56) TIME,PRATE,DF2,RLM,TM,TQM
   56 FORMAT (1X,"STAPAC",12F10.6)
      GO TO 58
C
C     NORMAL DIRECTED FORCE CALCULATION
C
   57 CALL DOT31 (D(1,1,NFS),QFU(1,J),TM)
      CALL CROSS (QFV(1,J),QFU(1,J),TQM)
   58 DO  59  I=1,3
      U1(I,NFS) = U1(I,NFS) + FRCE*TM(I)
   59 U2(I,NFS) = U2(I,NFS) + FRCE*TQM(I)
   60 CONTINUE
   99 CALL ELTIME (2,37)
      RETURN
      END
```

0 CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

DECKA	MAINA	ADJUST	AIRBAG	AIRBGG	AIRBG1	AIRBG3	BELTG
BELTRT	BGG	BINPUT	BLKDTA	CFACTT	CHAIN	CINPUT	CMPUTE
CONTCT	CROSS	DAUX	DAUX11	DAUX12	DAUX22	DAUX31	DAUX32
DAUX33	DAUX44	DAUX55	DHHPIN	DINT	DOTT31	DOTT33	DOT31
DOT33	DRCIJK	DRCYPR	DSETD	DSETQ	DSMSOL	DZP	EDEPTH
EFUNCT	EJOINT	ELONG	ELTIME	EQUILB	EULRAD	EVALFD	FDINIT
FINPUT	FLXSEG	FNTERP	FRCDFL	FSMSOL	GLOBAL	HBELT	HBPLAY
HEDING	HERRON	HICCSI	HINPUT	HPTURB	HSETC	IMPLS2	IMPULS
INITAL	INTERS	KINPUT	LINAXS	LOGAXS	LTIME	MAT31	MAT33
ORTHO	OUTPUT	PANEL	PDAUX	PLELP	PLSEGF	PLTXYZ	POSTPR
PRINT	PRIPLT	QSET	RCRT	ROTATE	ROT	RSTART	SEARCH
SEGSEG	SETUP1	SETUP2	SINPUT	SLPLOT	SPDAMP	SPLINE	SPRNGF
TRIGFS	UNIT1	UPDATE	UPDFDC	VEHPOS	VINPUT	VISCOS	VISPR
WINDY	XDY	YPRDEG	MAINB	CHANGE	GB16MAR81	GB23MAR81	CONTRL
CNSNTS	JBARTZ	TITLES	FORCES	RSAVE	CDINT	CDINT1	CDINT2
DAMPER	HRNESS	SGMNTS	DESCRP	CNTSRF	TABLES	VPOSTN	CMATRX
CEULER	FLXBLE	CSTRNT	TEMPVI	INTEST	INTSTD	COMAIN	ABDATA
CYDATA	WINDFR	TMPVSA	TMPVSI	TMPVSD	TMPVSH	TMPVSP	GB24MAR81
GB05APR81	GB21JUL81	GBDATE	GB29APR82	GB12MAY82	GB08JUN82	GB17DEC82	

0

0DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

YANK$$$	CONTRL	CNSNTS	JBARTZ	TITLES	FORCES	RSAVE	CDINT
CDINT1	CDINT2	DAMPER	HRNESS	SGMNTS	DESCRP	CNTSRF	TABLES
VPOSTN	CMATRX	CEULER	FLXBLE	CSTRNT	TEMPVI	INTEST	INTSTD
COMAIN	ABDATA	CYDATA	WINDFR	ARODAT	TMPVSA	TMPVSI	TMPVSD
TMPVSH	TMPVSP	DECKA	MAINA	ADJUST	AIRBAG	AIRBGG	AIRBG1
AIRBG3	AIRFLW	ARODTA	BELTG	BELTRT	BGG	BINPUT	BLKDTA
CFACTT	CHAIN	CINPUT	CMPUTE	CONTCT	CROSS	DAUX	DAUX11
DAUX12	DAUX22	DAUX31	DAUX32	DAUX33	DAUX44	DAUX55	DHHPIN
DINT	DOTT31	DOTT33	DOT31	DOT33	DRCIJK	DRCYPR	DSETD
DSETQ	DSMSOL	DZP	EDEPTH	EFUNCT	EJOINT	ELONG	ELTIME
EQUILB	EULRAD	EVALFD	FDINIT	FINPUT	FLXSEG	FNTERP	FRCDFL
FSMSOL	GLOBAL	HBELT	HBPLAY	HEDING	HERRON	HICCSI	HINPUT
HPTURB	HSETC	IMPLS2	IMPULS	INITAL	INTERS	KINPUT	LINAXS
LOGAXS	LTIME	MAT31	MAT33	ORTHO	OUTPUT	PANEL	PDAUX
PLELP	PLSEGF	PLTXYZ	POSTPR	PRINT	PRIPLT	QSET	RCRT
ROTATE	ROT	RSTART	SEARCH	SEGSEG	SETUP1	SETUP2	SINPUT
SLPLOT	SPDAMP	SPLINE	SPRNGF	TRIGFS	UNIT1	UPDATE	UPDFDC
VEHPOS	VINPUT	VISCOS	VISPR	WINDY	XDY	YPRDEG	MAINB

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CONTRL  CNSNTS  JBARTZ  TITLES  FORCES  RSAVE   CDINT   CDINT1
CDINT2  DAMPER  HRNESS  SGMNTS  DESCRP  CNTSRF  TABLES  VPOSTN
CMATRX  CEULER  FLXBLE  CSTRNT  TEMPVI  INTEST  INTSTD  COMAIN
ABDATA  CYDATA  WINDFR  ARODAT  TMPVSA  TMPVSI  TMPVSD  TMPVSH
TMPVSP
```

DECKS WRITTEN TO COMPILE FILE

```
DECKA   MAINA   ADJUST  AIRBAG  AIRBGG  AIRBG1  AIRBG3  AIRFLW
ARODTA  BELTG   BELTRT  BGG     BINPUT  BLKDTA  CFACTT  CHAIN
CINPUT  CMPUTE  CONTCT  CROSS   DAUX    DAUX11  DAUX12  DAUX22
DAUX31  DAUX32  DAUX33  DAUX44  DAUX55  DHHPIN  DINT    DOTT31
DOTT33  DOT31   DOT33   DRCIJK  DRCYPR  DSETD   DSETQ   DSMSOL
DZP     EDEPTH  EFUNCT  EJOINT  ELONG   ELTIME  EQUILB  EULRAD
EVALFD  FDINIT  FINPUT  FLXSEG  FNTERP  FRCDFL  FSMSOL  GLOBAL
HBELT   HBPLAY  HEDING  HERRON  HICCSI  HINPUT  HPTURB  HSETC
IMPLS2  IMPULS  INITAL  INTERS  KINPUT  LINAXS  LOGAXS  LTIME
MAT31   MAT33   ORTHO   OUTPUT  PANEL   PDAUX   PLELP   PLSEGF
PLTXYZ  POSTPR  PRINT   PRIPLT  QSET    RCRT    ROTATE  ROT
RSTART  SEARCH  SEGSEG  SETUP1  SETUP2  SINPUT  SLPLOT  SPDAMP
SPLINE  SPRNGF  TRIGFS  UNIT1   UPDATE  UPDFDC  VEHPOS  VINPUT
VISCOS  VISPR   WINDY   XDY     YPRDEG  MAINB
```

THIS UPDATE REQUIRED 37200B WORDS OF CORE.
*EOR

```
1  CSA   NOS/BE L564D        L564-CMR1  11/15/82
 10.17.58.GB19H1W  FROM    /9H
 10.17.58.IP  00000128 WORDS - FILE INPUT  , DC 04
 10.17.58.GB1,T200,IO300,CM60000,STCSA.    L800764
 10.17.58./BUTLER
 10.17.59. INTERCOM BATCH JOB - NO DECK
 10.17.59.ATTACH,OLDPL,ATBGBUPDATE1982.
 10.17.59.AT CY= 004 SN=AFIT
 10.17.59.ATTACH,NEWCOR,ATBGB17DEC82.
 10.17.59.AT CY= 002 SN=AFIT
 10.17.59.REQUEST,NEWPL,*PF.
 10.17.59.REQUEST,COMPILE,*PF.
 10.18.00.UPDATE,F,N,I=NEWCOR.
 10.18.30. 2 OVERLAPPING CORRECTIONS
 10.18.30. UPDATE COMPLETE.
 10.18.30.CATALOG,NEWPL,ATBGBUPDATE1982,RP=999.
 10.18.30.NEWCYCLE CATALOG
 10.18.31.CT ID=  L800764 PFN=ATBGBUPDATE1982
 10.18.31.CT CY= 005 SN=AFIT    0000076416 WORDS.
 10.18.31.CATALOG,COMPILE,ATBGBFORTRANATB1982,RP=1
 10.18.31.00.
 10.18.31.INITIAL CATALOG
 10.18.31.CT ID=  L800764 PFN=ATBGBFORTRANATB1982
 10.18.31.CT CY= 001 SN=AFIT    0000125824 WORDS.
 10.18.31.REQUEST,LGO,*PF.
 10.18.31.FTN,I=COMPILE,L=0.
 10.20.34.     35.309 CP SECONDS COMPILATION TIME
 10.20.34.CATALOG,LGO,ATBGBAIRFLOWBINARY1982,RP=99
 10.20.34.9.
 10.20.34.NEWCYCLE CATALOG
 10.20.34.CT ID=  L800764 PFN=ATBGBAIRFLOWBINARY1982
 10.20.34.CT CY= 002 SN=AFIT    0000052672 WORDS.
 10.20.34.OP  00007040 WORDS - FILE OUTPUT , DC 40
 10.20.34.MS  265344  WORDS  (  276288 MAX USED)
 10.20.34.CPA      40.866 SEC.        33.302 ADJ.
 10.20.34.IO      182.913 SEC.        54.142 ADJ.
 10.20.34.CM     4506.589 KWS.        21.228 ADJ.
 10.20.34.CRUS     108.673
 10.20.34.PP      133.852 SEC.     DATE 12/18/82
 10.20.34.EJ  END OF JOB, 9H  L800764.
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REFERENCES

1. Zember, Richard J. and Joan Cauby Robinette, July 1977, Bibliography of Research Reports and Publications - Impact, Vibration, Windblast and Escape (1942-1976), AMRL-TR-76-120.

2. Biodynamic Response to Windblast - AGARD Conference Proceeding No. 170 (Papers presented at meeting at Toronto, Canada, 6 May 1975) AGARD-CP-170, July 1975.

3. Payne, Peter R. and Fred W. Hawker, May 1974, USAF Experience of Flail Injury for Non-combat Ejections in the period 1964-1970, AMRL-TR-72-111.

4. Payne, Peter R., December 1974, Some Studies Relating to "Limb Flailing" After an Emergency Escape from an Aircraft, AMRL-TR-73-24.

5. Payne, Peter R., July 1975, Selected Topics on Tractor Escape Systems, AMRL-TR-75-9.

6. McDonald, A.B., August 1979, Advanced Design Aircrew Protective Restraint Systems, AMRL-TR-79-45.

7. Payne, Peter R., July 1975, Low-speed Aerodynamic Forces and Moments Acting on the Human Body, AMRL-TR-75-6.

8. Payne, Peter R., Fred W. Hawker and Anthony J. Euler, July 1975, Stability and Limb Dislodgment Force Measurements with the F-105 and ACES-II Ejection Seats, AMRL-TR-75-8.

9. Hawker, Fred W. and Anthony J. Euler, July 1975, Extended Measurements of Aerodynamic Stability and Limb Dislodgment Forces with the ACES-II Ejection Seat, AMRL-TR-75-15.

10. Hawker, Fred W. and Anthony J. Euler, June 1976, Wind Tunnel Measurements of Vertical Acting Limb Flail Forces and Torso/Seat Back Forces in an ACES-II Ejection Seat, AMRL-TR-76-3.

11. Schneck, Daniel J., December 1976, Aerodynamic Forces Exerted on an Articulated Body Subjected to Windblast, AMRL-TR-76-109.

12. Schneck, Daniel J., PhD, January 1979, Studies of Limb-dislodging Forces Acting on an Ejection Seat Occupant, AMRL-TR-78-103.

13. Hawker, Fred W., January 1979, Wind Tunnel Test of ACES-II Ejection Seat with Anthropometric Dummy in Asymmetric Configurations, AMRL-TR-78-108.

14. Anthony, Alastair, May 1979, Preliminary Analysis of Wind Tunnel Test of a 1/2 Scale Model of an Ejection Crewman and Ejection Seat, AMRL-TR-78-107.

15. White, Bobby J., April 1974, Aeromechanical Properties of Ejection Seat Escape Systems, AFFDL-TR-74-57.

16. Brinkley, James W., August 1975, Review of the Operational Efficacy of USAF Flight Helmets in Crash and Escape Environments, AMRL-TR-75-74.

17. Brinkley James W., August 1975, Wind Tunnel Tests of a USAF Flight Helmet and Loss Preventer, AMRL-TR-75-75.

18. Horner, Theodore W., DR. and Hawker, Fred W., May 1973, A Statistical Study of Grip Retention Force, AMRL-TR-72-110.

19. Grood, Edward S., PhD, Frank R. Noyes, M.D. and David L. Butler, PhD, October 1978, Knee Flail Design Limits: Background Experimentation and Design Criteria, AMRL-TR-78-58.

20. Engin, Ali Erkan, April 1979, Measurement of Resistive Torques in Major Human Joints, AMRL-TR-79-4.

21. Clauser, Charles E., John T. McConville and J.W. Young, August 1969, Weight, Volume, and Center of Mass of Segments of the Human Body, AMRL-TR-69-70.

22. Peters, J.M., February 1971, Static Center-of-gravity and Inertial Properties Measurements of Selected USAF Ejection Seats, AFFDL-TM-71-2-FER.

23. ACES-II - Advanced Concept Ejection Seat, Mc Donnell Douglas Report MDC J4578A.

24. Moy, Hammond R., January 1973, Advanced Concept Ejection Seat (ACES) Development and Qualification, ASD-TR-73-2.

25. Ewing, E.G., H.W. Bixby and T.W. Knacke, December 1978, Recovery System Design Guide, AFFDL-TR-78-151.

26. Data Package - AFFDL Ejecting Crewman Test at AEDC, Project Engineer W.D. Ervin, Project No. P41T-13, Test Period April 1978 - Unpublished.

27. Sub - and Transonic Wind Tunnel Measurements of the Forces Acting on a Crew Member and his Seat in Simulated Escape from an Aircraft by Payne, Inc., AMRL Contract No. F33615-79-C-0527, Unpublished.

28. Plotted Data - Annex to Report Sub - and Transonic Wind Tunnel Measurements on the Forces Acting on a Crew Member and his Seat in Simulated Escape from an Aircraft - Complete Plots of Experimental Data - Unpublished.

29. Jines, Lanny A., Hitech Ejection Seat Test No. 49E-J1 Front - Unpublished.

30. Cummings R.J. and F.E. Orsata, June 1979, Exploratory Development of Aircrew Windblast Protection Concepts, AMRL-TR-79-16.

31. Butler, F.E. and J.T. Fleck, May 1980, Advanced Restraint System Modeling, AFAMRL-TR-80-14.

32. Jines, Lanny A., Computer Simulation of Ejection Seat Performance and Preliminary Correlation with Emperical Data, AFFDL-TR-79-3150.

33. West, Christopher L., Brian R. Ummel and Roger F. Yorczyk, September 1980, Analysis of Ejection Seat Stability Using Easy Program, AFWAL-TR-80-3014(Vol. I).

34. Butler, F.E. and J.T. Fleck, December 1975, Development of an Improved Computer Model of the Human Body and Extremity Dynamics, AMRL-TR-75-14.

35. Butler, F.E. and J.T. Fleck, December 1981, Validation of the Crash Victim Simulator Volume 1, Engineering Manual - Part I: Analytical Formulation, Calspan Report No. ZS-5881-V-1.

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